electronics engineering issue

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electronics

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Life tests for Sprague's new Type 118P capacitors are the same as those for standard paper capacitors—140% *of rated voltage* for 250 hours at full rated temperature, 125°C. Dielectric tests, too, are the same as for comparable paper capacitors—*twice the rated voltage.*

Type 118P DIFILM capacitors may also be used at extremely low voltages. Capacitors in typical applications have been operated up to 5000 hours with only 2 volts applied without the non-clearable short circuits which have been typical of earlier metallized paper designs. The vibration and shock resistance of DIFILM Metallized Capacitors make them well-suited to missile electronics and similar applications.

The improved quality of these capacitors is the result of advanced manufacturing techniques combined with the development of new and better materials . . . all under strict quality control. Sprague is the only commercial capacitor manufacturer to metallize its own condenser tissue . . . the only manufacturer to continuously inspect all plastic film used to see that it meets rigorous Sprague standards. No wonder Sprague is first in quality metallized paper capacitors!

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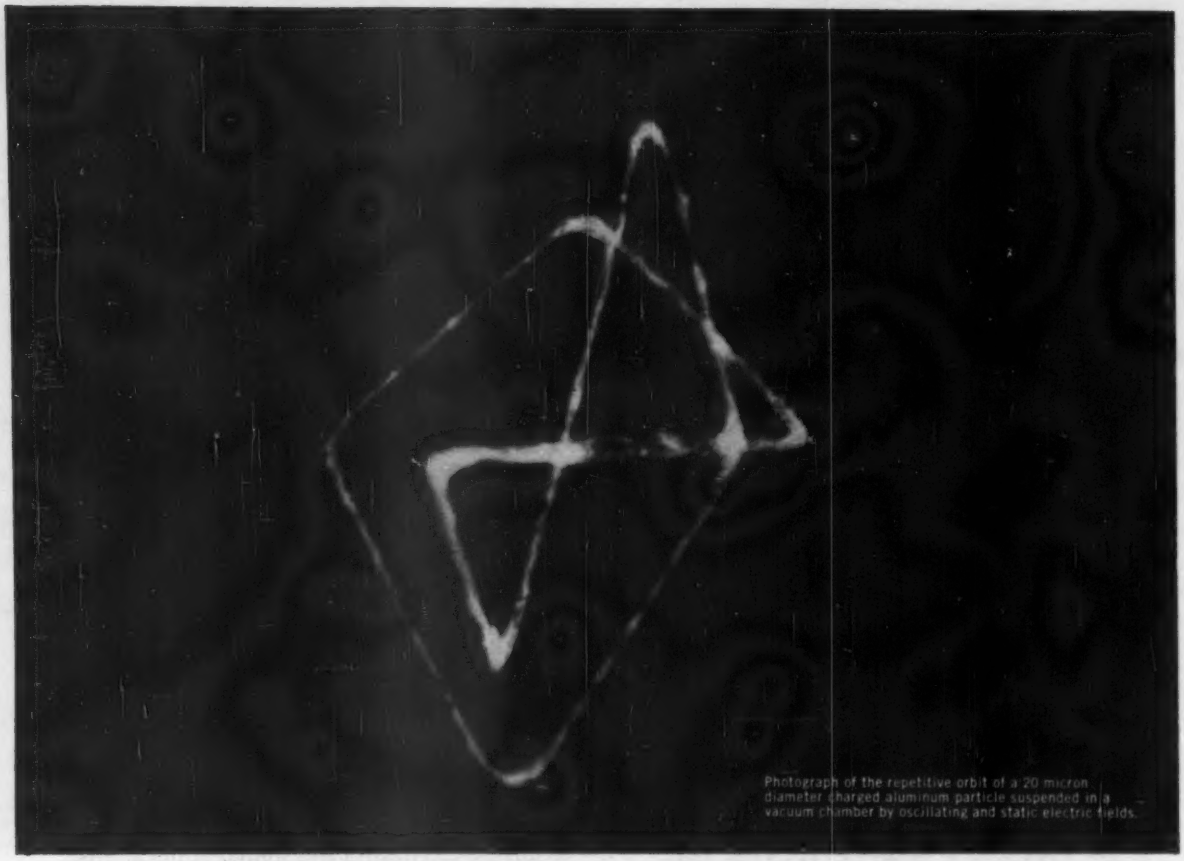

Photograph of the repetitive orbit of a 20 micron diameter charged aluminum particle suspended in a vacuum chamber by oscillating and static electric fields.

ELECTRODYNAMIC ORBITS

By the application of properly chosen alternating and static electric fields, electrically charged particles can be maintained in dynamic equilibrium in a vacuum against interparticle and gravitational forces. This is illustrated in the above photograph of the orbit of a charged dust particle. During the time of exposure the particle traversed the closed orbit several times, yet it retraced its complicated path so accurately that its various passages can barely be distinguished.

The range of particles of different charge-to-mass ratios which can be contained in this manner is determined by the gradients of the static and alternating electric field intensities and by the frequencies of the latter. In the absence of static fields and for a given electric field strength, the minimum frequency required for stable containment of the particles is proportional to the square root of their charge-to-mass ratios. Thus, charged colloidal particles require the use of audio frequencies, atomic ions need HF frequencies, while electrons require the use of VHF and higher frequencies.

Under the confining influence of the external fields, the particles are forced to vibrate with a lower frequency of motion which is determined by the external field intensities, space charge, and the driving frequencies. If the initial thermal energy is removed, a number of particles may be suspended in space in the form of a crystalline array which reflects the symmetry properties of the external electrodes. These "space crystals" can be repeatedly "melted" and re-formed by increasing and decreasing the effective electrical binding force. These techniques offer a new approach in the study of plasma problems and mass spectroscopy in what may be properly termed "Electrohydrodynamics."

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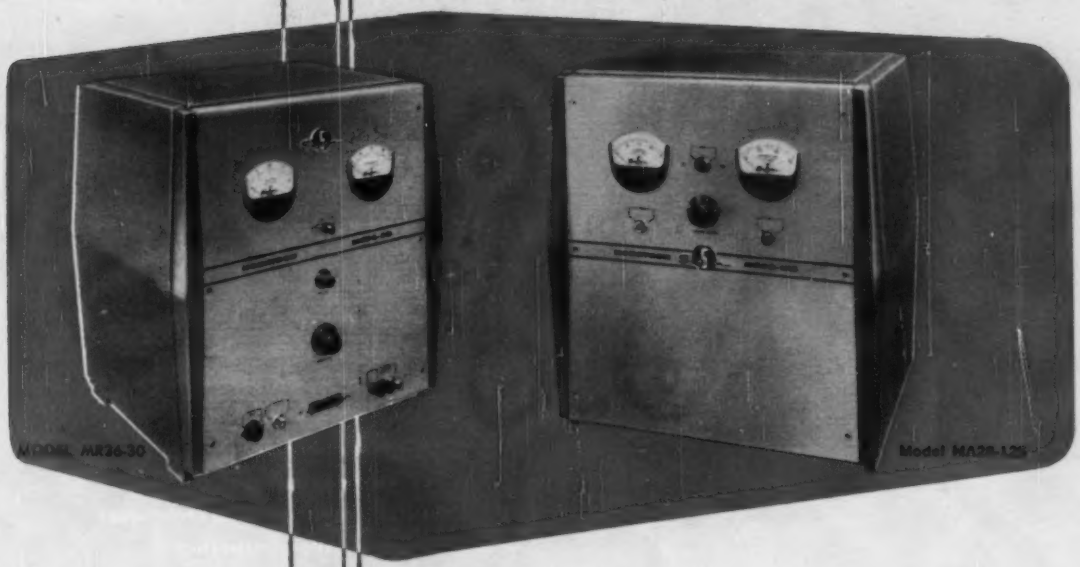
new High Current DC Supplies



Fast Response...High Amps...External Sensing

Model MA28-125
Output: 28 VDC nominal at 125 amps.
Regulation accuracy of ± 0.2%.
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Response time: < 0.1 second.
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Weight: 225 pounds.
$1160 in cabinet.*

Model MR36-30
Output current, 0-30 amps, output voltage, 5 to 36 VDC continuously adjustable with regulation ± 0.25% against line or load change.
Response time of 0.2 second.
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Weight: 175 pounds.
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Also supplied, as Model MR36-15, with output current 0-15 amps, otherwise similar.
Weight: 100 pounds.
$495 in cabinet.

*250 AND 500 AMP. MODELS NOW AVAILABLE

Two new high output power-packs—with response time ranging from 0.2 second down, and with transistorized power reference and magnetic amplifier power control circuits for trouble-free performance—that's just part of the story on these Sorensen DC power supplies.

One model supplies an output of *18 to 36 VDC at 125 amperes;* the other provides 5 to 36 VDC at 0 to 30 amps. Zener diode reference circuit assures sharper regulation, and the external sensing provision puts this precise control at the load. Silicon power rectifiers and complete tubeless design increase durability with reduction in weight—and greater saving in size.

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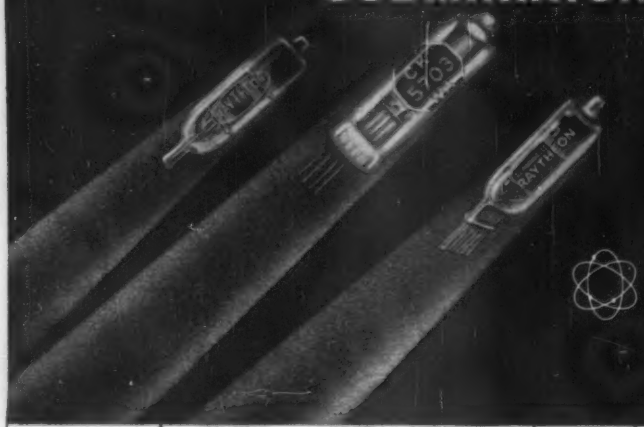
RAYTHEON
RELIABLE
SUBMINIATURE TUBES



provide utmost assurance against catastrophic failure — the result of Raytheon pioneered and perfected *dynamic quality control* including:

- X-ray analysis
- environment control
- advanced welding techniques
- microscopic inspection

Type	Description	Heater current at 6.3V mA	Plate and Screen Volts	Plate mA	μ	Sm μmhos	Vibration Output (max.) mVac
5639	Video Amplifier Pentode	450	150*	21		9000	100†
5643	Thyratron	150	epx = 500v max; ip = 100 mA max; Ip = 16mA dc max				
5702WA	Video Amplifier Pentode	200	120	7.5		5000	50†
5702WB	Video Amplifier Pentode	200	120	7.5		5000	50† 240#
5703WA	High Frequency Triode	200	120	9.4	25.5	5100	10†
5703WB	High Frequency Triode	200	120	9.4	25.5	5000	10† 50#
5704WA	High Frequency Diode	150	Max I_o = 10 mA				
5744WA	High Mu Triode	200	250	4.2	70	4000	25†
5744WB	High Mu Triode	200	250	4.2	70	4000	15† 75#
5783WA	Voltage Reference	Operates at approximately 85 volts between 1.5 and 3.5 mA					20†
5784WA	RF Mixer Pentode	200	120	5.5		3200	100†
5784WB	RF Mixer Pentode	200	120	5.5		3200	75† 300#
5787WA	Voltage Regulator	Operates at approximately 98 volts between 5 and 25mA					20†
5829WA	Dual Diode	150	max I_o = 5.5 mA per plate				
5902	Beam Power Pentode	450	110	30		4200	100†
6021	Medium Mu Dual Triode	300	100	6.5	35	5400	50†
6111	Medium Mu Dual Triode	300	100	8.5	20	5000	50†
6112	High Mu Dual Triode	300	100	0.8	70	1800	25†
6247	Low Microphonic Triode	200	250	4.2	60	2650	2.5†
6247WA	Low Microphonic Triode	200	250	4.2	60	2650	2.5† 25#
6533	Low Microphonic Triode	200	120	0.9	54	1750	1.0†
6533WA	Low Microphonic Triode	200	120	0.9	54	1750	1.0† 15#
6832	Medium Mu Dual Triode (balanced)	400	100	0.8	26	1050	10†
6872	Video Amplifier Pentode	200	120	7.75		4100	50†

All ratings for dual tubes are for each section. *Screen Voltage = 100 Vdc #Peak to peak, 15G, 30 to 1000 cps. †15G, 40 cps fixed frequency

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ELECTRONICS NEWSLETTER

ELECTRONIC TELETYPEWRITER combining keyboard sending and electrostatic recording was demonstrated last week by the Army. The 3,000-word-per-minute unit was developed by Burroughs and the Army Signal Research and Development Labs. The electrostatic recording technique creates a charge pattern on high-resistivity paper which is made visible by application of powdered ink and permanently fixed by heat. Each recording head consists of a 5 by 7 wire matrix. There are 72 individual character recording heads in a line. The printer will operate at 750 wpm in military applications. Input to the printer will be start-stop teletypewriter code.

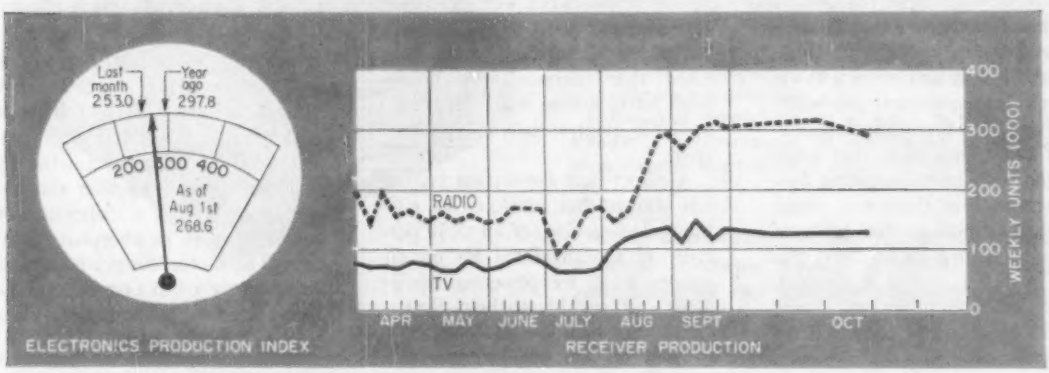
ELECTRONICS ENGINEERS will be in greatest demand when present senior classes graduate next June, according to a report of the University of Michigan's College of Engineering. At the same time, says the report, overall demand for engineering graduates will be higher. This jibes with earlier reports of a worsening engineer shortage (ELECTRONICS, p 21, Oct. 17).

• **Last year** at U-M salaries for B. S. grads averaged $480 a month, up $15, with the Master's level up $18 to $570 and the doctorate up $52 to $732. Electrical and electronic products rose from fourth to first place in the ranking of industries by average salaries offered.

SOVIET BLOC BRIEFS: Russia has purchased from a British consortium, Rustysa Ltd., a monitoring and recording system for a British-built tire plant. System was developed by British Iron and Steel Research Association and is being manufactured by Digital Engineering Co., London. Some 500 detection points will collect and transmit data to a control room.

• **Polish Academy of Sciences** is just reported to have completed two-year development of an electronic computer with about 500 tubes and more than 10,000 parts. Computer is described as similar to a British machine, with capability of performing 800 arithmetical and logical elementary problems per second.

FLUOROSCOPE SCREEN, said to permit brighter images and less danger to patients from overexposure to X-rays, is reported by Westinghouse. Consultant Georges Destriau, member of the University of Paris faculty, is credited with the development, which is dubbed an "electroenhancement screen." Phosphor is sandwiched between two glass plates, the surfaces of which have been treated to conduct electricity. Firm says technique involves simultaneous application of an electric field during fluoroscoping; it claims this provides greater enhancement of the image than is the case with a conventional screen using X-rays alone.



FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	Oct. 17, '58	Oct. 10, '58	Oct. 18, '57
Television sets, total	124,503	127,125	153,846
Radio sets, total	287,829	314,684	411,273
Auto sets	73,754	93,088	150,638

STOCK PRICE AVERAGES

(Source: Standard & Poor's)	Oct. 22, '58	Oct. 15, '58	Oct. 23, '57
Radio-tv & electronics	61.21	59.76	41.28
Radio broadcasters	74.08	72.66	52.02

FIGURES OF THE YEAR

Totals for first eight months

	1958	1957	Percent Change
Receiving tube sales	251,657,000	297,281,000	—15.3
Transistor sales	25,310,834	15,611,300	+62.1
Cathode-ray tube sales	4,952,862	6,236,890	—20.6
Television set production	2,950,455	3,756,533	—21.5
Radio set production	6,611,686	8,765,606	—24.6
TV set sales	2,862,452	3,746,794	—23.6
Radio set sales (excl. auto)	4,111,080	4,947,006	—16.9

MORE FIGURES NEXT PAGE

Motor hot enough to grill steak (left) tests new insulation system, while thermoelectric generator converts heat into electricity as . . .

New Materials Make Hit

'Hot-rock' insulation, new thermoelectric junction materials hold promise for our industry

PITTSBURGH, PA.—Importance of new materials to the electronics industry was shown dramatically at the Westinghouse Research Laboratories recently. Featured were new materials for thermoelectric junctions, new approaches to solving some problems of new semiconductors and a new high-temperature insulation.

Demonstrated was a hot-cold-light panel that may bring even more electronics into the American home. The demonstration panel, 12 in. square and 4 in. thick, consists in cross section of a three-plate electroluminescent sandwich, a battery of thermoelectric elements and a back plate that could be fitted with heat-dissipating fins.

Panels such as these may someday be mounted on the walls of homes to furnish light, heat the home in winter, cool it in summer.

The electroluminescent panel provides light output equivalent to a 25-w light bulb, is driven by a 3-kc supply. Color of the demonstration device was blue; but yellow, green, white and red are available—depending upon excitation frequency and phosphor. The thermoelectric elements can create a range of surface temperature from 40 to 130 F. Westinghouse claims the panels will be commercially available in five years. The thermoelectric junctions, which operate on the Peltier effect, were described as bimetallic junctions using special alloys. Company sources indicated that thermoelectric household refrigeration units might be available commercially within two years.

A direct heat conversion system was shown that promises to give thermal efficiencies of 10 to 30 percent. It was suggested for use in remote areas, for powering equipment and possibly to help electrical utilities handle peak loads.

Key to successful operation are the materials used for the hot and cold junctions. Westinghouse is investigating mixed valence oxides, intermetallics and other semiconductors. Efficiency of devices demonstrated was about 5 percent; more efficient materials are needed. Bismuth telluride was mentioned as a low-temperature junction material; mixed-valence oxides, such as manganese oxides with lithium added, were mentioned as affording stable operation at high temperatures. Engineers indicated that the junctions would be stacked to get the best physical and electrical characteristics at any given junction temperature with the system.

Scientists demonstrated the technique of nuclear magnetic resonance acoustic absorption. This is a means of mechanically vibrating a specimen which is placed in a polarizing magnetic field. This technique will permit studying the 3-5 valance intermetallic compounds, as well as metals in bulk, to check on electron mobilities. Intermetallics have not hitherto been amenable to nmr investigation due to r-f skin effect losses when a swept-frequency oscillating magnetic field was applied.

The firm showed an electric motor operating at 1,200 F to demonstrate dramatically the properties of a new inorganic insulating material. Known as "hot rock," the material consists of glass impregnated with phosphate. Specifically: the phase and slot insulation of the motor consists of glass cloth and large mica flakes bonded with phosphate. The wire was insulated by covering it with glass fiber and impregnating it with a suspension of powdered mica in phosphate solution. The motor was potted with a liquid slurry consisting of a phosphate solution, wollastonite, silica

(Continued on p 12)

TRANSISTOR AND TUBE SALES, MONTHLY

(Source: EIA)	Aug., '58	July, '58	Aug., '57
Transistors, units	4,226,616	2,631,894	2,709,000
Transistors, value	$9,975,935	$6,598,762	$6,598,000
Receiving tubes, units	30,456,000	30,795,000	43,029,000
Receiving tubes, value	$25,442,000	$26,927,000	$34,886,000
Picture tubes, units	713,458	549,817	930,296
Picture tubes, value	$14,190,878	$11,109,048	$17,984,185

EMPLOYMENT AND EARNINGS

(Source: Bur. Labor Statistics)	Aug. '58	July, '58	Aug. '57
Prod. workers, comm. equip.	354,900	340,600	409,800
Av. wkly. earnings, comm.	$82.39	$80.75	$77.81
Av. wkly. earnings, radio	$81.40	$80.39	$75.81
Av. wkly. hours, comm.	39.8	39.2	39.9
Av. wkly. hours, radio	39.9	39.6	39.9

Vibration and Shock

ENGINEERING REPORT

A Case History of Environmental Control...No. 3

PROBLEM

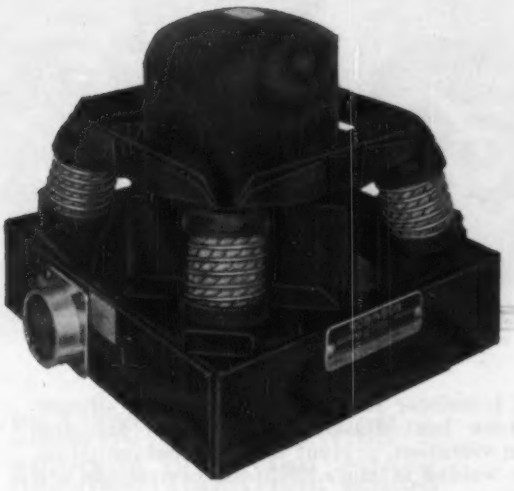
TO PROTECT VERTICAL GYROSCOPE in jet fighter radar fire-control systems from shock and vibration of combat maneuvers, gunfire recoil, and rough landings.

SOLUTION

ENGINEERED MOUNTING SYSTEM

MODEL 1995 safeguards vital aircraft performance and equipment reliability.

Robinson MET-L-FLEX resilient cushions of specially fabricated stainless steel wire provide a greater damping factor—actually 5 times that of rubber. Lasting performance of the all-metal mounting system is assured regardless of exposure to oil, dirt, moisture, ozone, and temperature extremes.



MODEL 1995
MOUNTING SYSTEM

SPECIAL FEATURES:

Angled resilient elements add to equipment stability, reduce space requirements, and contribute to excellent rotational stability characteristics.

PERFORMANCE:

With a vibratory input acceleration of 10 G, Model 1995 provides 94% isolation efficiency in the 200-350 c.p.s. frequency range allowing only .6 G to reach the equipment. Vertical and horizontal natural frequency is 13.7 and 8.6 c.p.s. respectively. Due to high damping, peak acceleration force to which equipment is subjected is limited to 1.4 G at mounting system resonance.

Rotational displacement of gyro, a critical factor affecting performance, is controlled to a fraction of a degree even during resonant conditions.

RESULT:

More dependable operation of the radar fire control system, hence greater operational reliability of the aircraft through application of a Robinson shock and vibration control mounting system.

By applying Robinson's concept of controlled environment in the design of MET-L-FLEX suspension systems, more than thirty-seven different gyro mountings have been successfully developed and produced in quantity.

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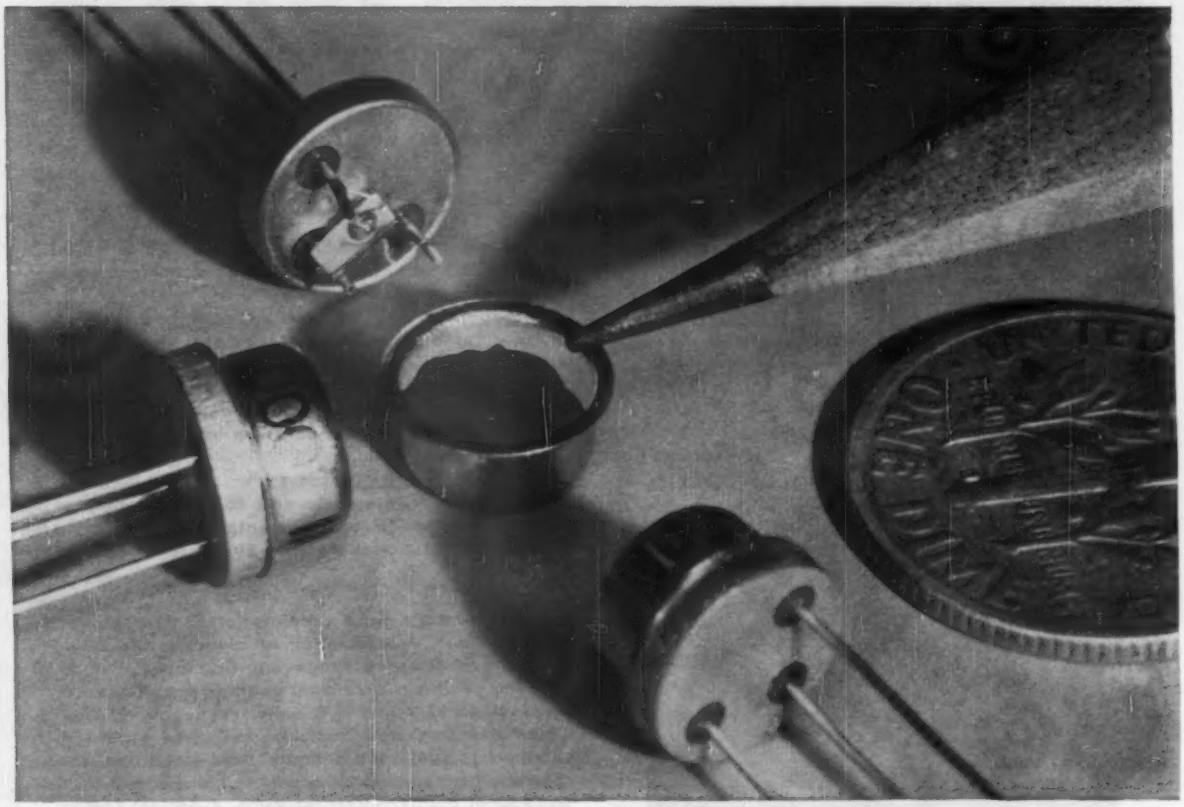
West Coast Engineering Office: Santa Monica, Calif.

Design better products with

DOW CORNING SILICONE COMPOUNDS

improve transistor performance



Made by Industro Transistor Corp., these miniature transistors are potted with a Dow Corning silicone compound to cushion vibration, improve heat disspation, prevent contamination of the junction.

TYPICAL PROPERTIES OF DOW CORNING COMPOUNDS

Color	colorless, translucent
Penetration (ASTM D216-52T)	
unworked	200 to 240
worked, maximum	300
Electric Strength, volts per mil, at 10 mils	500
Dielectric Constant at 23 C (ASTM D150-54T)	
at 100 kc	2.85
Condition C-96/23/96†, at 100 kc	3.00
Dissipation Factor at 23 C (ASTM D150-54T)	
at 100 kc	0.0009
Condition C-96/23/96†, at 100 kc	0.003
Arc Resistance, seconds (ASTM D495-55T)	80

† Condition C, tested after 96 hours at 96 percent relative humidity and 25 C.

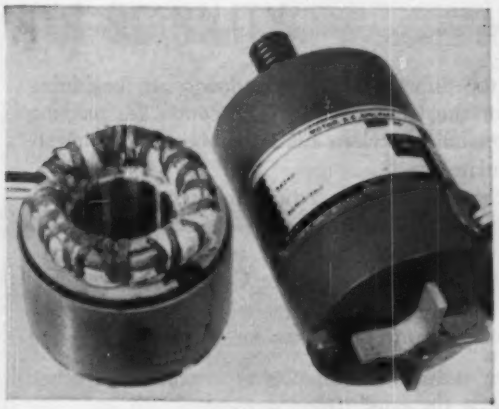
Used for potting transistor junctions, Dow Corning silicone compounds improve heat dissipation, serve as damping agents to cushion vibration, prevent metallic contamination when covers are welded in place. Silicone compounds are inert, nonmelting, nongumming . . . maintain their grease-like consistency over a temperature span from as low as −75 C to 200 C and higher. In addition to transistor potting, Dow Corning silicone compounds are used in a wide variety of electronic components and devices to protect against arcs, grounds, shorts; impart a high order of surface resistivity. Silicone compounds apply easily, need no cure. Free sample available.

CIRCLE 103 READER'S SERVICE CARD

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

Dow Corning Silicone Dielectrics

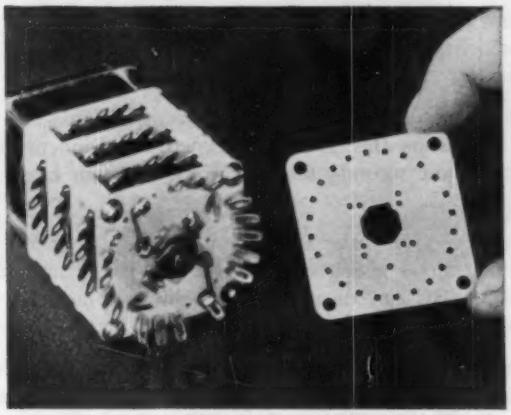


AiResearch miniature motor combines Sylkyd wire and silicone varnish.

REDUCE SIZE, WEIGHT WITH SILICONE INSULATING MATERIALS

Specify Sylkyd® enameled magnet wire to help reduce the size and weight of transformers, servo motors, and other devices by as much as 50%. Equal in diameter to Class A magnet wires, it serves at 180 C . . . withstands the higher temperatures of miniaturization. Impregnated with Dow Corning 997 Varnish, Sylkyd enameled magnet wire and other silicone insulating components are bonded into moisture resistant insulation systems having high dielectric strength, maximum reliability over a wide range of temperatures and environmental conditions. Write for new, illustrated brochure.

CIRCLE 104 READER'S SERVICE CARD



Shallcross Manufacturing rotary switch decks.

SILICONE-GLASS LAMINATES RESIST CONTINUOUS 250 C HEAT

Laminates made of glass cloth bonded with Dow Corning silicone resins provide heat-stable structural and insulating materials . . . withstand soldering heat during assembly of electronic equipment . . . resist continuous exposure to temperatures up to 250 C. Silicone-glass laminates resist moisture, arcing, corona. They are lightweight, strong, rigid . . . supplied in many shapes and forms by leading laminators.

CIRCLE 105 READER'S SERVICE CARD

SILASTIC ENCAPSULATION ABSORBS VIBRATION, SHOCK

Sensitive electronic parts withstand vibration and shock longer when encapsulated with Silastic®, the Dow Corning silicone rubber. That's because Silastic retains all its superior properties on aging. Silastic has low moisture absorption, stays resilient over a wide temperature range . . . is easy to apply. Available in many forms, including molded parts, extrusions, tapes, sheets and pastes.

CIRCLE 106 READER'S SERVICE CARD

Electronic tube encapsulated with Silastic.

and other chemically reactive materials.

Potted motor was dried free of moisture and pyrolyzed above 600 F to develop heat properties. Conducting parts of the motor were made of silver. Experimental graphite bearings were used although the insulated conductors could be handled in a conventional manner for winding.

Engineers indicated that the material might be brittle although it was strong and had excellent insulating properties. They said they had not tried potting electronic circuits in the new material and, consequently, were not now sure of its dimensional stability, dielectric constant and r-f properties as related to electronics.

Major near-future application seems to be in special rotating machinery for high-temperature applications, such as nuclear reactors and missile control systems.

Air Force Using Time-Share Link

"WE'RE ALL HEPPED UP about it."

That's the way an Air Force development engineer described reactions to the time-division data-link developed to carry orders from Sage's FSQ-7 computer to the aircraft that execute the orders.

The data-link, comprising a ground based system designated AN/GKA-5 plus airborne receivers, sends out messages which convey complete instructions or sets of instructions to the pilot of an aircraft. The messages are addressed to specific craft, permitting the Sage system to concentrate its effort where needed. By contrast, an automatically commutating system would sequence through all addresses, touch base with each one once a cycle, without provision for varying degrees of need.

Additionally, there is no theoretical limit on the number of "channels"—addresses—that the system can handle. The only practical limitation is the frequency with which any addressee must be contacted under worst-case conditions.

The solid-state AN/GKA-5 employs some 7,200 transistors and

WASHINGTON OUTLOOK

THE FEDERAL COMMUNICATIONS COMMISSION is now being pressured from a new direction.

Federal courts, from the Supreme Court on down, are beginning to make things rough for the Commission. The courts are reacting to charges of improper relations between FCC members and interests they are supposed to regulate.

Latest examples: (1) Supreme Court's action, telling a lower court to reconsider FCC decisions moving vhf television channels out of Springfield, Ill. and Peoria, Ill. and (2) FCC's award of a contested tv channel in Orlando, Fla. Testimony before Congressional investigators indicated the Springfield and Orlando cases had been discussed with members of the Commission outside regular hearings.

The Court's action may mean reexamination of a handful of other channel shifts FCC made at the same time.

For years, the courts regularly turned down requests to upset FCC decisions. This gave the Commission leeway to function as a body of experts in the field of broadcasting and communications regulation.

The courts have not yet directly challenged the Commission's expert status. The cases which have gone against FCC all involve possible improper outside pressures that guided a decision.

By looking over the Commission's shoulder this way, the courts have, in effect, told the Commission this: Either act expertly and independently or face more and more second-guessing of your decisions by the courts.

This pressure could help turn the tide in one important area of FCC's work: The question of giving FCC authority to regulate the broadcasting networks. FCC can already move in this area indirectly, through its authority over individual stations.

- **The Electronic Industries Assn.** and other defense producer spokesmen are up in arms over the Pentagon's upcoming changes in military procurement regulations dealing with allowable costs on defense contracts. The new rules are out by Jan. 1.

  The controversy revolves primarily around two provisions: The new listing of allowable costs will apply both to cost-reimbursement type contracts and to fixed-price contracts in which costs are a factor in negotiations (price-redetermination contracts).

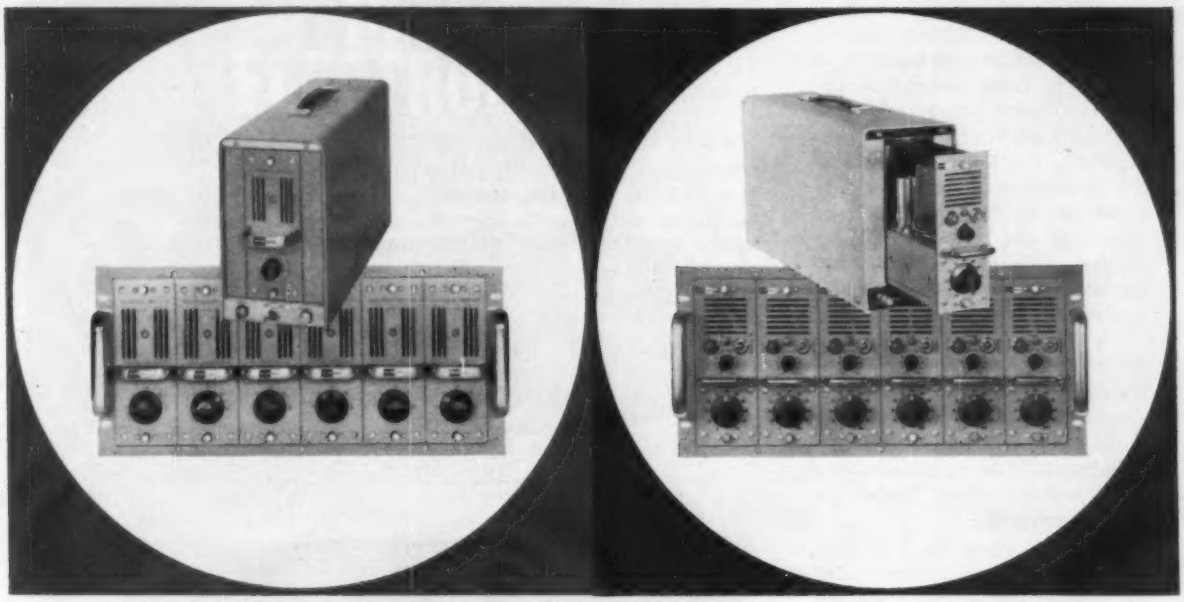
  At present, fixed-price contracts are not generally subject to allowable cost review. Industry men charge it would be unfair for military procurement officials to audit itemized contract costs after negotiation of a fixed-price contract.

  Also, industry men say all costs on defense contracts should be charged to the government. The Pentagon says no, but has already made some concessions.

  The Pentagon will now allow as reimbursable costs executive bonuses and other special employee compensation relating to profits, training and education costs. At present, there are no fixed rules on these, but such costs are generally not allowed.

AMPLIFY MICROVOLTS

WITH STABILITY... measure strain, temperature, other phenomena, to 0.1% with a KIN TEL DC amplifier



NEW...TRUE DIFFERENTIAL DC AMPLIFIERS ELIMINATE GROUND LOOP PROBLEMS...RESCUE MICROVOLT SIGNALS FROM VOLTS OF NOISE

160 db DC, 120 db 60 cycle common mode rejection with balanced or unbalanced input ■ Input completely isolated from output ■ Input and output differential and floating ■ 5 microvolt stability for thousands of hours ■ 0.05% linearity, 0.1% gain stability ■ Gain of 10 to 1000 in five steps ■ >5 megohms input, <2 ohms output impedance ■ 10 volt at 10 ma output ■ 120 cycle bandwidth ■ Integral power supply

Ideal for thermocouple amplification, the Model 114A differential DC amplifier eliminates ground loops; allows the use of a common transducer power supply; drives grounded, ungrounded or balanced loads; permits longer cable runs; and can be used inverting or non-inverting. The 114A can be mounted in either single amplifier cabinets or six amplifier 19" rack adapter modules. Price: 114A – $775; six amplifier module – $200; single amplifier cabinet – $125.

WIDEBAND, SINGLE ENDED DC AMPLIFIERS AMPLIFY DATA SIGNALS FROM DC TO 40 KC WITH 2 MICROVOLT STABILITY

±2 microvolt stability ■ <5 microvolt noise ■ 40 kc bandwidth ■ 100 KΩ input, <1 ohm output impedance ■ Gain of 20 to 1000 in ten steps with continuous 1 to 2 times variation of each step ■ ±45 V, ±40 ma output ■ 1.0% gain accuracy ■ 0.1% gain stability and linearity ■ Integral power supply

Millions of cumulative hours of operation have proved KIN TEL Model 111 series DC amplifiers to be the basic component for all data transmission, allowing simple, reliable measurement of strain, temperature and other phenomena. DC instrumentation systems – with their inherently greater accuracy, simplicity, and reliability than AC or carrier systems – are made entirely practical by the excellent dynamic performance, stability, and accuracy of KIN TEL DC amplifiers. Price: 111BF–$575; six amplifier module–$200; single amplifier cabinet – $125.

5725 Kearny Villa Road, San Diego 11, California

KIN TEL
A Division of Cohu Electronics Inc.

9,500 diodes, uses electron tubes only in the transmitter and receiver. It needs 1.6 kw of power for digital data gear and 3 kw for transmitter and receiver power.

Basic requirement of the data-link is to take Sage tactical data and reconvert the data to an air message. Airborne equipment receives and translates the message, and displays the instructions for the pilot. Each FSQ-7 feeds a group of GKA-5's, and each of these data-link centrals transmits to a score or more manned or unmanned aircraft in its subsector.

Every GKA-5 receives each message from the Sage, but only the one controlling the affected subsector acts on it. Similarly all the planes in the subsector receive the ground-to-air message, but only the addressee plane interprets and displays the message for its pilot.

The ground transmitter is a uhf set which modulates a carrier in binary code by conventional frequency-shift key techniques. The carrier could, ELECTRONICS learned, simultaneously be voice-modulated to 30 percent without loss of any digital intelligence.

Land lines from the Sage central to data-link transmission points are supplied by Western Electric's digital data service. The FSQ-7 computer works into a digital data transmitter supplied by WE which takes the computer data and breaks it up for transmission over twinned land lines as a sinusoidal signal. Digital data receivers at the end of the land lines recombine the signal and present it to the GKA-5 data multiplexer. The multiplexer selects the messages addressed to it, edits out anything the aircraft doesn't need, and prepares the ground-to-air message which is then sent out to the craft.

The rate at which these messages are received, processed and retransmitted is among the many system characteristics still classified. It is known, however, that each GKA-5 can keep messages going to all planes in an Air Force squadron as fast as the pilots could possibly act on them.

The USAF system is compatible with Navy's USC-2 time-division data-link, to be used on the *Triton* (ELECTRONICS, p 20, Sept. 19).

MILITARY ELECTRONICS

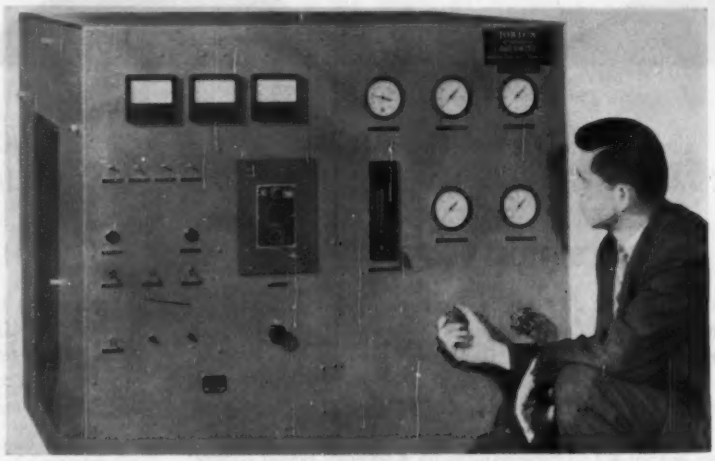
• **Radio transmitter** in Vanguard I has been operating 7½ months. Hoffman Electronics, producer of the silicon solar cells, says the solar energy converter has a life expectancy of up to 10,000 years. Cells consist of thin wafers of highly purified silicon diffused with minute quantities of arsenic and boron. Sputnik III, launched May 15, also uses solar cells and is still transmitting.

• **X-15 will use** liquid nitrogen, contained at approximately −300 F, to cool and pressurize electronic equipment and to make environmental atmosphere inert. The nitrogen will be applied as liquid, spray and gas to meet its various requirements. To ensure a constant flow to needed areas, pressurized helium will be used to expel the nitrogen.

• **First U.S. attempt** to use a space vehicle as a ground communications relay station was successfully carried out with the second lunar probe vehicle, USAF ballistic missile chief Maj. Gen. Bernard A. Schriever has revealed.

Tracking stations at Cape Canaveral, Manchester, England, and Hawaii were in communication with each other via the radio repeater station situated in the lunar vehicle.

• **Test range** for the X-15, costing $3 million, will be completed by Jan. 1. Located in Nevada, the range consists of radar, telemetering, data-handling and special communications equipment. Construction of the range and development of special electronic equipment by Electronic Engineering Co. was under the supervision of the Air Force. The range will be operated by the National Aeronautics and Space Administration.

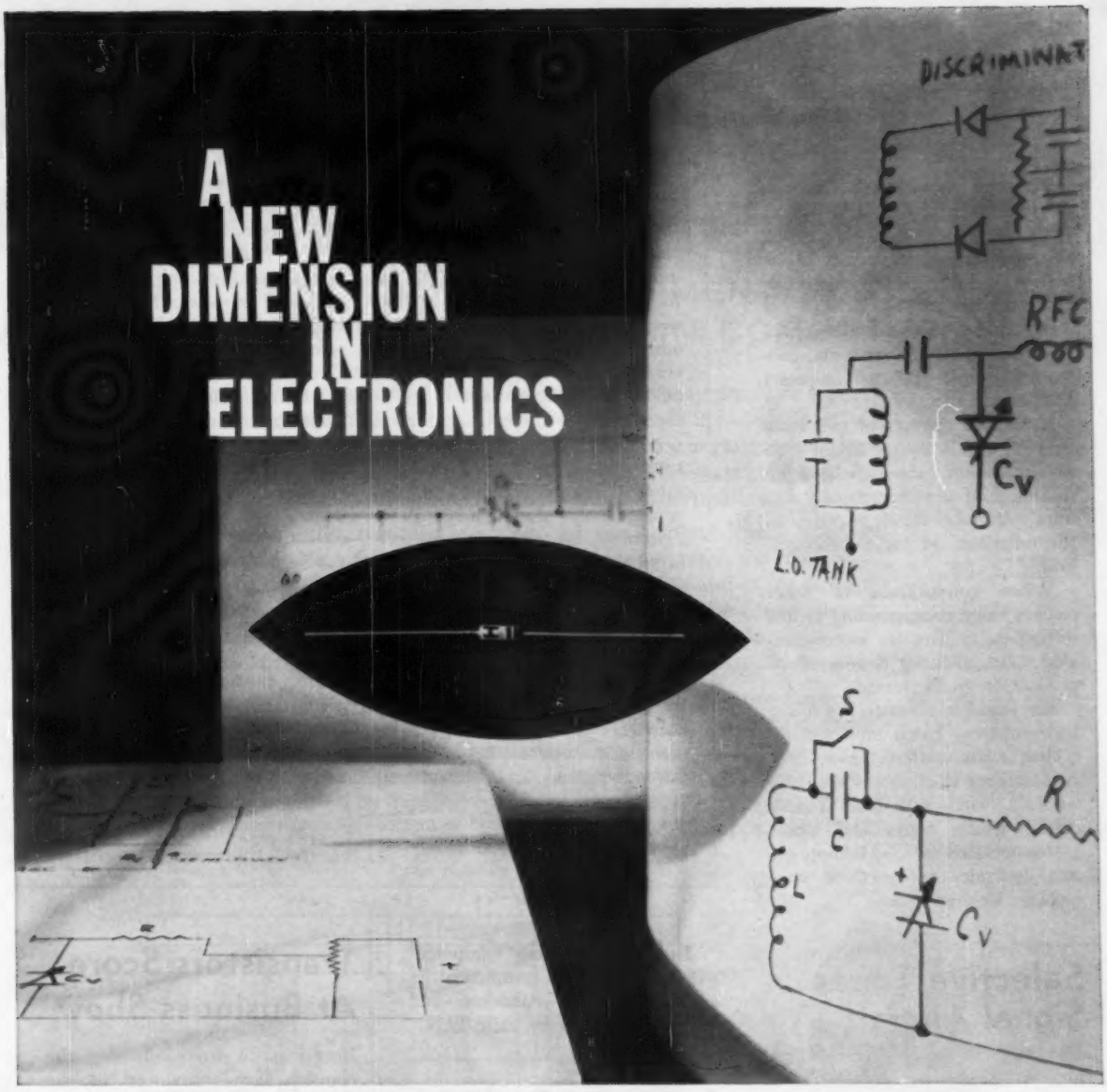


Small model of saline water conversion plant can produce 500 to 1,000 gals. per day as . . .

Circuits Run Water Desalter

ELECTRONIC DEVICES control liquid level and monitor conductivity in new salt-water conversion plant at restaurant on New York State Thruway, in Junius Ponds, N. Y.

Desalter, built by Ionics, Inc., of Cambridge, Mass., for New York State Thruway Authority, removes approximately 200 pounds of undesirable salts and other dissolved solids each day from 12,000 gallons of brackish well water to



The Hughes silicon capacitor is a new kind of device whose full impact upon semiconductor electronics has yet to be determined. Most certainly, the silicon capacitor uncovers an entire realm of possibilities. Desirable equipment not now existing can be made for the first time. And, in every instance, bonus benefits of reduced size and weight plus greater simplicity result.

Our brochure, "The Hughes Silicon Capacitor," discusses this series and many of its applications in detail. For your copy, please write:

Hughes Products, Marketing Department, International Airport Station, Los Angeles 45, Calif.

Some Suggested Applications:

Non-Mechanical Tuning: The effect upon tuned circuit design is tremendous. Hughes silicon capacitors replace bulky air condensors and permit remote-control tuning at the end of a long wire. With these capacitors, instantaneous and non-mechanical "signal seeking" features can be designed into tuned circuits.

Automatic Frequency Controls: Here the silicon capacitors replace a reactance tube. Output voltage from the discriminator varies the voltage on the silicon capacitor—hence, the local-oscillator frequency—to correct for any frequency drift.

Dielectric Amplifiers: Operation is based on the amplitude modulation of a high-frequency carrier source by a Hughes silicon capacitor, and on the subsequent demodulation and filtering at the output.

Also: Pulse Circuits, Frequency Modulation, RC Oscillators, Modulators, Electronically Controlled Filters.

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

© 1958, Hughes Aircraft Company

produce potable water for all phases of restaurant operations.

Most extensive use of the equipment is in arid regions of the Middle East.

Heart of water demineralizer is electric membrane stack, which takes advantage of the fact that salt and mineral molecules in solution separate into electrically charged particles.

A bridge-type controller monitors conductivity of water and controls discharge of batch at preset level of salinity.

Controller consists of two basic circuits: a Wheatstone bridge with an electron-ray tube as balance indicator, and a self-contained vacuum tube relay which operates on the unbalance of the Wheatstone bridge.

When conductance of water reaches value corresponding to dial setting, relay actuates motor-operated valve, allowing demineralized product to go to storage.

For liquid level control in filling and emptying batch tank and recycling water until demineralized, two stainless steel probes send signal to a switch with built-in relay circuit which opens and closes motor-operated valve. Holding circuit overrides intermediate contacts on steel probes.

FINANCIAL ROUNDUP

• **Sanborn Co.** of Waltham, Mass., manufacturer of electronic instruments for medical and industrial uses, issued 118,530 shares of common at $16 per share last month. On day stock was offered for sale price rose to $26 on the over-the-counter market. Previously, all common stock in the 41-year-old firm had been held by officers and employees.

• **Nuclear-Chicago,** manufacturer of nuclear instruments, privately places $600,000 of 5½-percent notes due Feb. 1, 1971. Placement was made with an institutional investor through Loewi & Co., Milwaukee.

• **Westinghouse Electric** registers $10 million of participations in its employee savings plan with the SEC. At same time it also registered 149,254 shares of its common stock which may be purchased under the plan.

• **General Aero & Electronics** publicly offers 500,000 shares of common stock at $2.25 per share. Proceeds from sale of 400,000 shares will be used to acquire stock of **National Missile & Electronics** of Van Nuys, Calif., and for additional working capital and other corporate purposes. National Missile concentrates activities in development and consulting field, but General Aero plans to set up manufacturing facilities in the southern California area. It expects to make collision scanners, transducers and potentiometers. Willis E. Burnside of New York City is the underwriter.

• **Seeburg Corp.,** Chicago, Ill., obtains $3,150,000 loan due in 1963 at 5 percent from First National Bank of Chicago. Seeburg produces coin-operated phonographs, missile components, facsimile equipment and other electronic products. Proceeds will be used to retire $1,250,000 of 6-percent senior debentures, due in 1961, and $1,037,500 of 6-percent junior subordinated notes, due in 1962.

Selective Tones Signal Aircraft

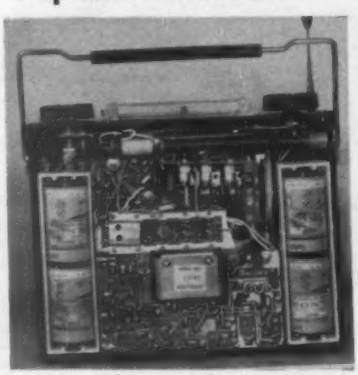
DEVELOPMENT in aviation slated for this Winter is the installation of equipment to provide selective calling between ground stations and in-flight aircraft.

The new system will be used to alert planes on an individual basis to messages intended for them. Manufacturers of the equipment, Motorola Inc., say it will reduce crew fatigue caused by constant monitoring of message channels.

Under the new system, a light or chime will notify the crew that a transmission intended for them is ready, in much the same way a ringing telephone shows someone is "on the line." This is done by transmitting tone codes for the particular aircraft from the ground station. A decoder in the aircraft is receptive only to its own tone pattern.

The special calling equipment will be installed in commercial jet airliners for Pan American and American Airlines by early 1959.

Japanese Radio



All-transistorized f-m/a-m portable radio made by Sony Corp. of Tokyo uses 15 transistors, operates on four standard flashlight batteries, weighs 5½ lb

Transistors Score At Business Show

BUSINESSMEN from all over the country were introduced to the transistor at the National Business Show in New York's Coliseum last month.

The semiconductor devices were not themselves displayed among any of the products on exhibit at this 15th annual show of business-office equipment. But a visitor who stopped at a booth featuring electronic products soon found himself listening to a sales talk on the virtues of transistorization.

Transistor promotion was particularly noticeable among manufacturers exhibiting computers, intercommunication systems, dictating machines and message transmission equipment.

One manufacturer told ELECTRONICS that the particular virtue

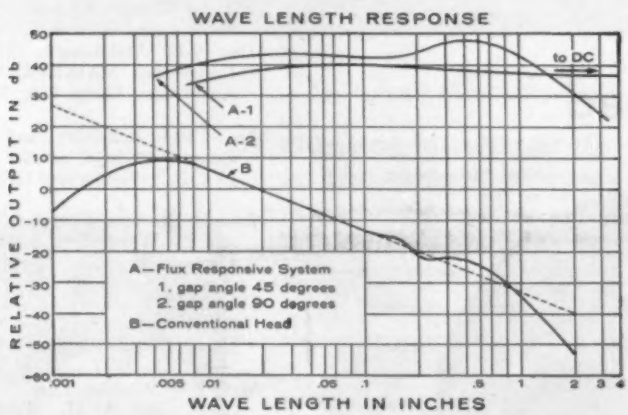
CLEVITE 'BRUSH'
Flux-Responsive Magnetic Heads

REDUCED BUFFER STORAGE EQUIPMENT, FASTER DATA ACCESS, EARLIER RELEASE OF MAIN COMPUTER

Clevite "Brush" Flux-Responsive Heads respond to the magnitude of signal flux instead of the rate of flux change. Output of flux heads is independent of tape or drum speed and, therefore, independent of frequency or pulse repetition rate. The signal reproduced by the flux-responsive head is an accurate facsimile of the recorded flux pattern and of the original recorded information.

The output of a computer, recorded at high speed, can be played back later at much slower speeds with a flux-responsive head to exactly match the relatively slow processing rate of typewriters, card punching machines and other output devices. Clevite Flux-Responsive Heads can also operate in the conventional manner. This permits one head to search recorded data at high speed, locate it, and then be switched to flux-responsive operation for operating of output devices.

Special flux-responsive heads have been developed by Clevite to meet specific customer applications. They are now commercially available in 1 to 32 channel form in a variety of mechanical configurations. These designs, slightly modified, may fit your present requirements. One of our specialists will be pleased to discuss your application by detailed correspondence or personal visit. Write: Product Manager, Magnetic Heads, Clevite Electronic Components, 3311 Perkins Avenue, Cleveland 14, Ohio.



Typical Clevite multi-channel flux-responsive head, with .032 in. track and .070 in. spacing.

Clevite 'Brush' Flux-Responsive Heads for low speed or static read-out of digital information • reproduction of high frequency analog recording at low tape speeds • extended-period process control • reproduction of low frequency recording • measurement of low angular or low linear velocities and recorded transients • position control

CLEVITE ELECTRONIC COMPONENTS

DIVISION OF CLEVITE

MAGNETIC HEADS
TRANSDUCERS
PIEZOELECTRIC CRYSTALS, CERAMICS AND ELEMENTS

of transistorization to him was its salability. Improved tone quality was attributed by some dictating machine and intercom makers to use of solid-state devices.

Philco had a private show with its large-scale all-transistorized computer, the Transac S-2000.

One manufacturer offered a system for transmitting communications in longhand over telephone wires. Units used for sending and receiving messages are the size of a small adding machine, or smaller. Use of transistors made the small size possible, said the Electrowriter division of Comptometer Corp.

Ham Network Lists Lectures

FALL SERIES of technical symposiums for members of the First Army's Military Affiliate Radio System has been announced by technical director S. E. Piller.

The MARS network is composed of radio amateurs who participate in instruction courses by ham radio each Wednesday at 9 p.m. EST at 4,030 kc upper sideband. All hams are invited to listen in even though they are not members of the MARS organization.

The November talks scheduled are: "Application of Transistors in SSB Equipment", "Ionospheric Storms and Their Effect on Radio", "The Engine Scope", "Compatible Single Sideband".

December's lectures will be on: "International Radio Communication Systems", "F-M Multiplex Stereo System", "VHF Radio Propagation".

New England to Exhibit Products

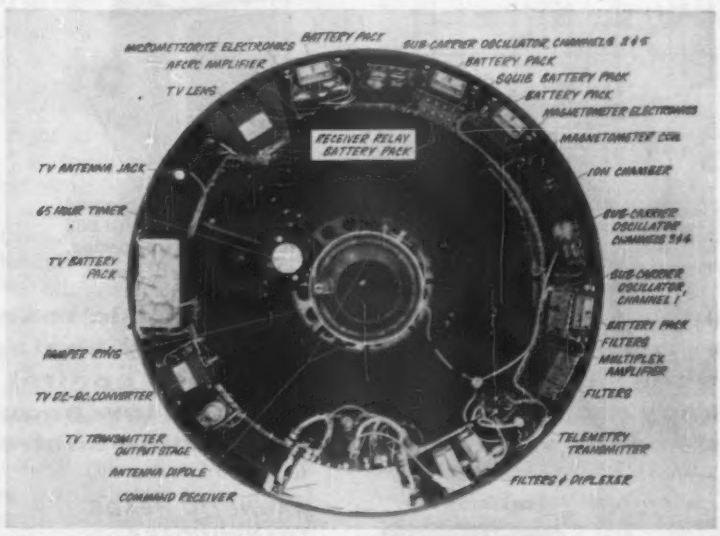
BOSTON—Many new products will be exhibited and several original papers will be delivered Nov. 19-20 at the annual NEREM show here.

The Northeast Electronics Research and Engineering Meeting will take place in Mechanics Hall.

There will be more than 200 exhibitors. Technical sessions will cover computers, components, techniques, circuits, reliability and testing, electron devices and information theory.

Show's theme is "Today's Electronic Developments — Tools for Tomorrow." A session on inventions and patents will approach the subject from inventors', commercial and legal viewpoints.

Pioneer I's Payload



Here are inside details of Pioneer I instrumentation package Air Force sent aloft in lunar probe project directed by Space Technology Labs. Glass fiber chamber surrounds payload's 22 items

MEETINGS AHEAD

Nov. 6-7: Nuclear Science Meeting, 5th Annual, PGNS of IRE, Villa Motel, San Mateo, Calif.

Nov. 10-12: Physics and Medicine of the Atmosphere and Space, USAF School of Medicine, Hilton Hotel, San Antonio, Tex.

Nov. 17-20: Magnetism and Magnetic Materials, AIEE, APS, IRE, ONR, Sheraton Hotel, Philadelphia.

Nov. 17-20: Weather Radar Conf., Univ. of Miami, Miami Beach, Fla.

Nov. 19-20: Northeast Electronics Research and Eng. Meeting, NEREM, IRE, Mechanics Hall, Boston.

Nov. 19-21: Electrical Techniques in Medicine and Biology, AIEE, ISA, PGME of IRE, Nicollet Hotel, Minneapolis.

Dec. 2-4: Reliable Electrical Connections, EIA, Statler-Hilton Hotel, Dallas.

Dec. 3-5: Global Communications, AIEE, PGCS of IRE, Colonial Inn-Desert Ranch, St. Petersburg, Fla.

Dec. 3-5: Eastern Joint Computer Conf., AIEE, ACM, IRE, Bellevue-Stratford Hotel, Philadelphia.

Dec. 4-5: Vehicular Communications, Annual Meeting, PGVC of IRE, Hotel Sherman, Chicago.

Dec. 9-11: Mid-America Electronics Convention, MAECON, Municipal Auditorium, Kansas City, Mo.

Jan. 12-14: Reliability and Quality Control, PGRQC of IRE, ASQC, EIA, Bellevue-Stratford Hotel, Phila.

Jan. 29-30: Long-Distance Transmission By Waveguides, Institution of Electrical Engineers, London, Eng.

Feb. 12-13: Transistor & Solid-State Circuit Conf., AIEE, PGCT of IRE, Univ. of Pennsylvania, Philadelphia.

Mar. 3-5: Western Joint Computer Conf., AIEE, ACM, IRE, Fairmont Hotel, San Francisco.

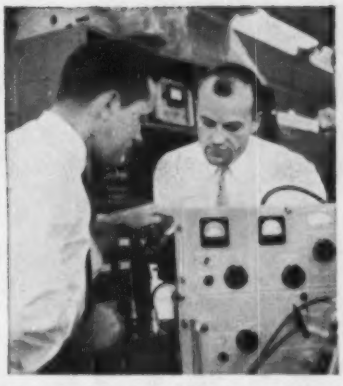
Mar. 23-26: Institute of Radio Engineers, IRE National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.

Mar. 26: Quality Control Clinic, 15th Annual, ASQC, Univ. of Rochester, Rochester, N. Y.

Apr. 5-10: 1959 Nuclear Congress, sponsored by over 25 major engineering and scientific societies, Public Auditorium, Cleveland.

In Development Engineering—meet two men who get results

Hunting ducks or developing military systems ... teamwork pays off



Here Mr. Harpole and Mr. Coon check out the Radar Systems Tester recently developed by General Mills. Both men are Registered Professional Engineers. Each has an impressive record of achievement in his special fields. Coon and Harpole—two more of the many good reasons our customers say, "At General Mills, we get results."

Sighting his bird is Ken Coon, manager of the Guidance and Navigation Laboratory at the Mechanical Division of General Mills. The second nimrod is Murray Harpole, manager of our Communications and Control Laboratory.

In a duck pass, these engineers cooperate to bring home the bag limit. At the plant, they cooperate to transform ideas into reality.

Their engineering groups work independently, each with clearly designed areas of responsibility but each recognizing an essential interdependence.

This broad, overall awareness of "target" and the cooperative method of achieving it are the *plus capabilities* which enable General Mills to produce military systems and sub-systems to the strictest specifications—in the shortest possible time.

NEW BOOKLET RIGHT OFF THE PRESS tells and shows the many ways we serve industry and the military. Write for your copy. Address Dept. EL-11

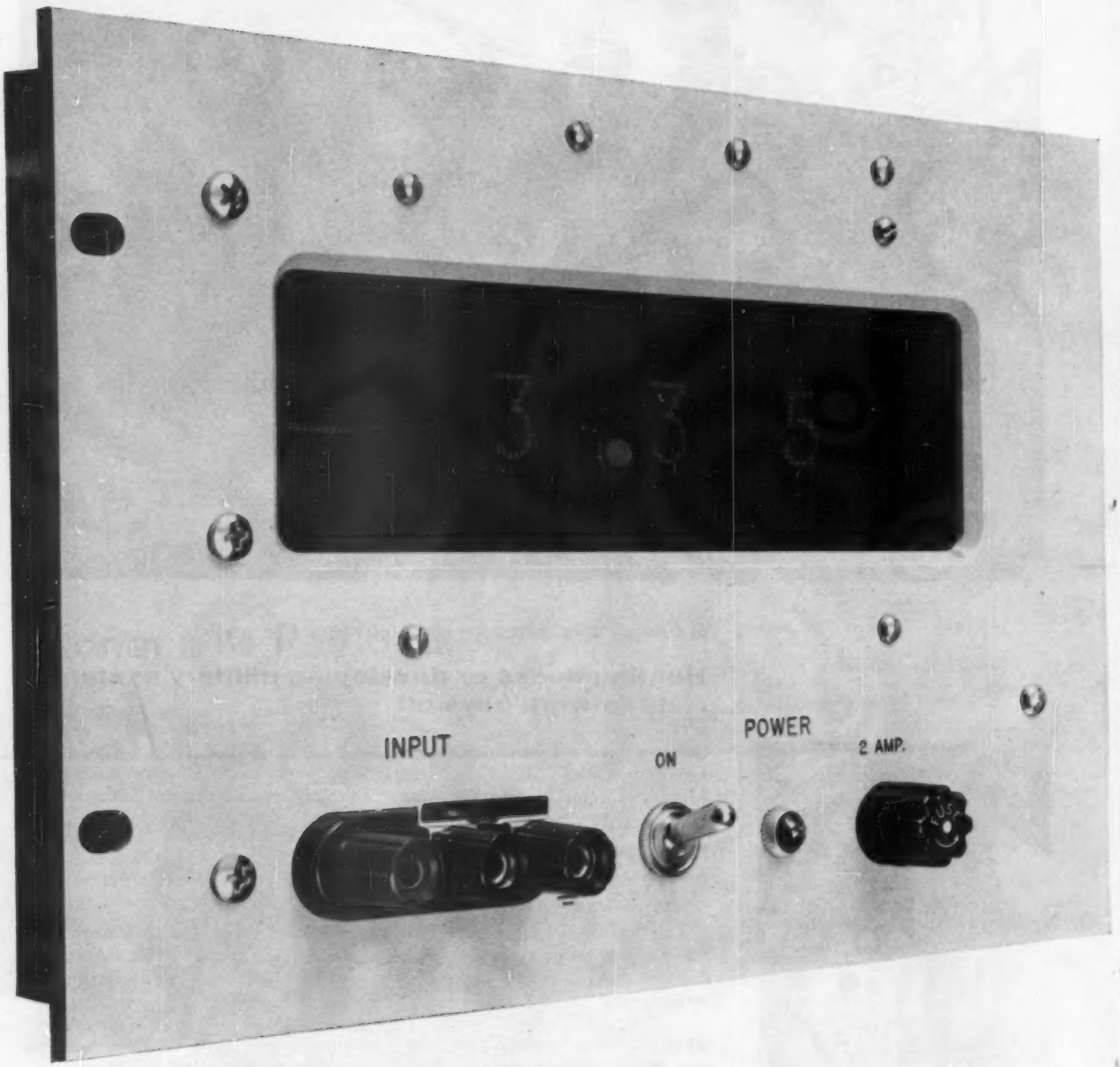
MECHANICAL DIVISION

1620 Central Avenue, Minneapolis 13, Minnesota

General Mills

To wider worlds through intensive research • creative engineering • precision manufacturing

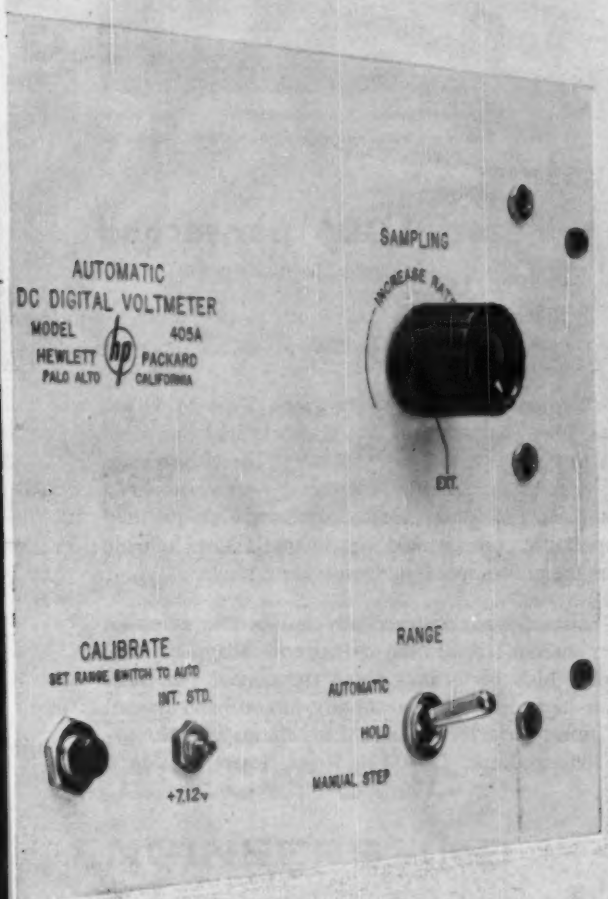
Automatic range
Just apply the probe and



7" high. Actual size.

and polarity selection. read voltage directly!

Digital Voltmeter, $825



405AR DC DIGITAL VOLTMETER is a completely new instrument providing, literally, "touch-and-read" voltage measurements between 1 and 1,000 volts. *Range, even polarity, are automatically selected.* Readout is in-line, in bright, steady numerals.

New, novel circuitry provides a stability of readings virtually eliminating jitter in the last digit. This reduces operator fatigue and avoids uncertainty.

Special features include a floating input, electronic analog-to-digital conversion, digital recorder output and front-panel "hold" control permitting manual positioning of decimal. Voltage sampling rate is variable from 1 reading every 5 seconds to 5 per second; or can be controlled externally by a 20 v positive pulse.

BRIEF SPECIFICATIONS

Range:	0.001 to 999 v dc; 4 ranges.
Presentation:	3 significant figures, polarity indicator
Accuracy:	±0.2% full scale ±1 count
Ranging time:	⅓ sec to 2 sec
Input impedance:	11 megohms to dc, all ranges
Response time:	Less than 1 sec
AC rejection:	3 db at 0.7 cps; min. 50 db at 60 cps
Price:	$825.00

HEWLETT-PACKARD COMPANY

5024A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.

CABLE "HEWPACK" • DAVENPORT 5-4451

FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

Data subject to change without notice. Price f.o.b. factory.

Newest

HONEYWELL MINIATURE RATE GYROS

Rugged enough to withstand 100 G shock

Typical M Series Gyro undergoes 20 G Linear Vibration Test with no deterioration of performance.

Model M-1
shown actual size

Sensitive enough to detect 0.005° per second

Honeywell's newest miniature rate gyros, Type M Series, are rugged enough to withstand repeated shocks and linear accelerations up to 100 G yet sensitive enough to detect turn rates of only 0.005 degrees per second. A damping ratio variation of 2 to 1 or better is maintained without heaters by a unique fluid damped, temperature compensated system that assures reliable operation over the entire operating temperature range.

Type M Series Gyros are specifically designed for autopilot damping, radar antenna stabilization and fire control applications. Their small size, high performance and ruggedness suit them particularly for high performance military aircraft and guided missile applications. Write for Bulletin M to Minneapolis-Honeywell, Boston Division, Dept. 7, 40 Life Street, Boston 35, Mass.

DESCRIPTIVE DATA

FULL SCALE RANGE: to 400 degrees per second

THRESHOLD-RESOLUTION: 0.005 degrees per second

LINEARITY: 0.1% to 2% depending on range

DAMPING: 2 to 1 (or better)

TEMPERATURE RANGE: −65 to +200 and +250°F

SHOCK AND ACCELERATION: 100 G

VIBRATION: 20 G to 2000 cps

PICKOFF: Variable Reluctance type providing infinite resolution and high signal-to-noise ratio

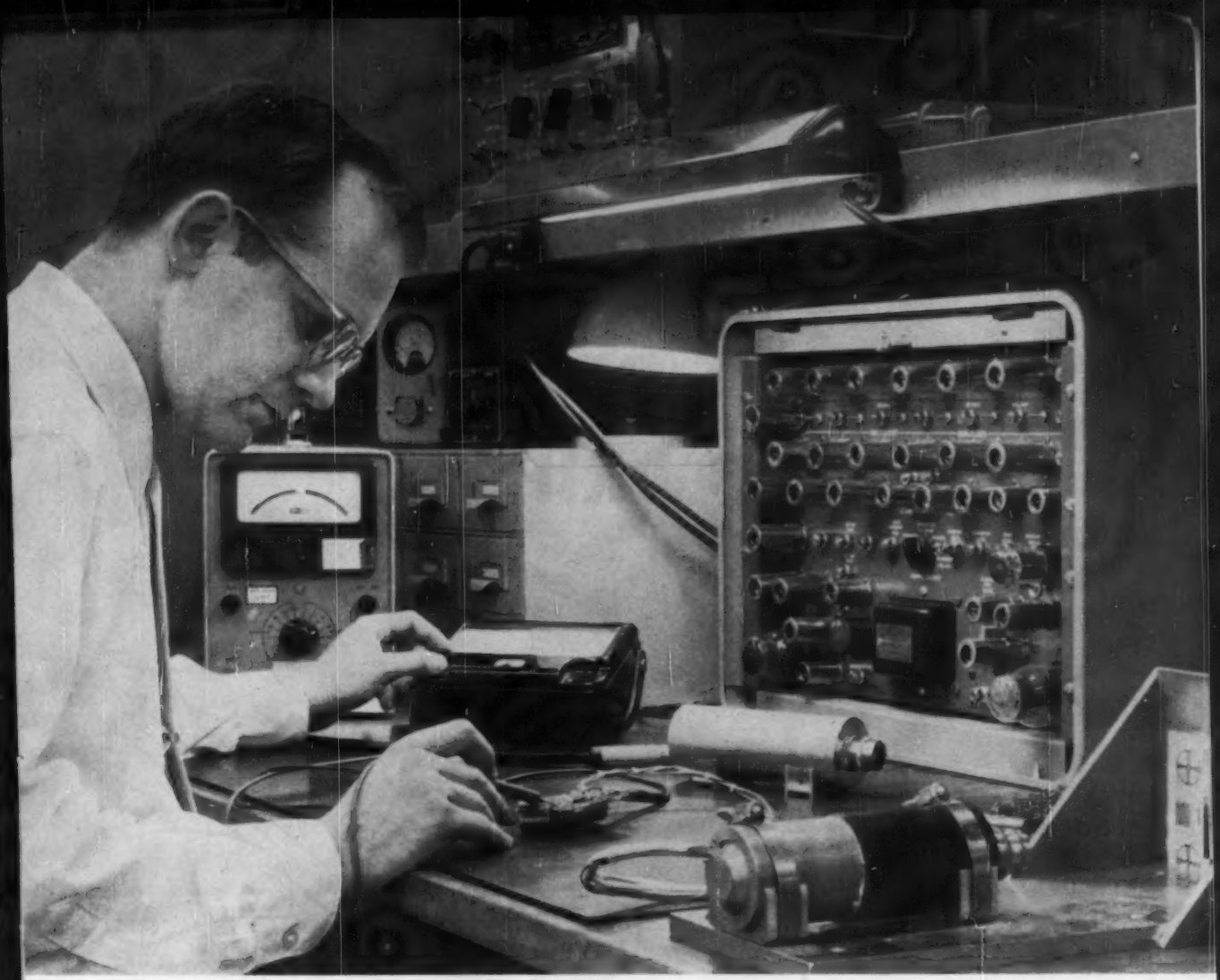
MOTOR EXCITATION: 26 volts, 400 cps (standard) 2 phase and 3 phase

SIZE: 1″ diameter, 2¾″ long

WEIGHT: 4.5 ounces

Honeywell

Military Products Group



A MISSILE AND TELEVISION INDUSTRY FIRST. Lockheed-developed, miniaturized TV cameras, designed for both government and commercial use. Only 6 inches long and 2¼ inches in diameter, tiny cameras extend man's vision into the unexplored. Unmanned lunar probes to the far side of the moon; lunar landings; monitoring interiors of manned spacecraft and remote TV coverage of on-the-spot happenings on a scope never before possible are some of the uses foreseen for the cameras.

ELECTRONIC ENGINEERS AND SCIENTISTS

Lockheed Missile Systems Division is systems manager for such major, long-range programs as the Navy Polaris IRBM, Earth Satellite, Army Kingfisher, Air Force X-7 and Q-5 ramjet vehicles, and other important research and development programs.

Responsible positions for high-level, experienced personnel are available in research and development, in our project organizations, and in manufacturing.

Particular areas of interest include microwave, telemetry, radar, guidance, solid state, reliability, data processing, instrumentation, servomechanisms, flight controls, circuit design and systems analysis, test, infrared, and optics.

If you hold a degree and are experienced in one of the above fields, we invite your inquiry. Please write to Research and Development Staff, Dept. 2211, 962 W. El Camino Real, Sunnyvale, California.

Lockheed

MISSILE SYSTEMS DIVISION

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, VANDENBERG AFB, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO

Reeves INSTRUMENT CORPORATION

achieves

DRAMATIC REDUCTION IN GYRO DRIFT...

CONDENSED PERFORMANCE DATA

Trimmed drift rate:
0.1°/hr. rms
0.3°/hr. max.

Mass unbalance:
5.0°/hr./g

Anisoelastic constant:
0.025°/hr./g² rms

Maximum command turning rate:
over 20°/sec.

Dimensions:
2″ dia., 4″ long

IN NEWEST DESIGN 20 IG INTEGRATING GYROS

Representing a major breakthrough by Reeves' gyro research laboratories, these advanced instruments show a small fraction of the drift rate hitherto considered low for high-performance units in this class.

Other characteristics are also outstanding, including extremely low anisoelastic constant and high command turning rate.

Of equal importance is the fact that these instruments measure up in every way to well-known Reeves standards of precision, ruggedness and RELIABILITY in regular production models. They are now available, and we invite your inquiries for detailed information.

Other Reeves Gyros and Accelerometers meeting equally exacting standards for performance and reliability include a comprehensive series of 10 IG, 20 IG and HIG 5 Integrating Gyros; 20 PIG Pendulous Integrating Gyros and 10A and 20A Linear Accelerometers. Technical information on request.

Reeves INSTRUMENT CORPORATION

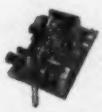
REEVES INSTRUMENT CORPORATION
A Subsidiary of Dynamics Corporation of America
Roosevelt Field, Garden City, New York

1RV58

REAC Analog Computers

Precision Floated Gyros

Precision Resolvers and Phase Shifters


Servo Mechanical Parts

CIRCLE 16 READERS SERVICE CARD

CIRCLE 17 READERS SERVICE CARD →

1K20 Series X and K Band Klystron (left)
1K125C Series C Band Klystron (right)

Eimac Announces...

Six New Ceramic Reflex Klystrons

Two important frequency ranges in the C, X and K bands are now covered by Eimac ceramic reflex klystrons. Eimac's advanced stacked ceramic design gives these tubes exceptional ruggedness and frequency stability.

The four new tubes of the 1K20 series cover 8500 to 11,700 Mc. at power levels to 50 milliwatts. These tubes are specifically designed for use in the severe vibration and temperature environment of air-borne and missile radar systems. They will withstand vibration levels of 15G in any reference plane with less than 100 kilocycle frequency deviation. Rated for use at any altitude, the 1K20 series tubes are conservatively rated at +250°C seal temperature. A new non-contacting, non-microphonic tuner permits noise-free tuning of the tubes through their complete ranges. Low beam voltage requirement and simple radiation cooling minimize the weight and complexity of associated equipment.

Two new C-band tubes comprising the 1K125 series cover 3700 to 5000 Mc. Power levels up to 2 watts make these tubes ideal for reliable broadband point-to-point communication. Tuning by dielectric slug rather than variable RF gap avoids sensitivity to shock and vibration. Integral-finned cooler and higher operating temperature ratings minimize cooling requirements.

Eimac know-how in the field of ceramic-metal tube design now brings compactness, ruggedness, high performance and reliability to these important microwave frequencies.

For further information request a copy of the brochure "A New Line of Eimac Reflex Klystrons"

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA
Cable Address: EIMAC, SAN CARLOS

Eimac First for ceramic reflex klystrons

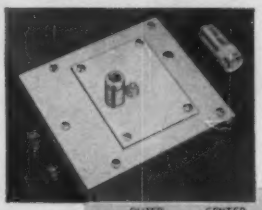
Eimac®

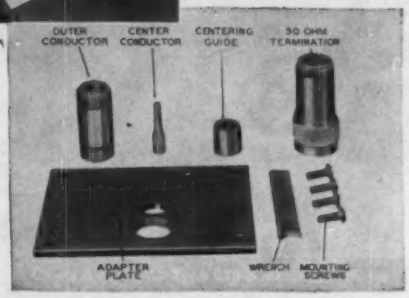
GENERAL CHARACTERISTICS

Type	Freq. Range Mc.	Beam Voltage	Power Output Range	Reflector Voltage
1K125CA	3700-4400	1000 Vdc	1.5 to 2.0 W	0 to —500 Vdc
1K125CB	4400-5000	1000 Vdc	2.0 to 2.3 W	0 to —500 Vdc
1K20XS	8500-9300	300 Vdc	25 to 50 mW	0 to —250 Vdc
1K20XK	9200-10,000	300 Vdc	25 to 50 mW	0 to —250 Vdc
1K20XD	10,000-10,800	300 Vdc	25 to 50 mW	0 to —250 Vdc
1K20KA	10,700-11,700	300 Vdc	25 to 50 mW	0 to —250 Vdc

BRC RX Meter combines all necessary RF Bridge Test functions

Completely self contained . . . quick, easy broad band measurements, on components or coaxially connected elements





Co-ax Adapter Kit Type 515-A adapts RX Meter for coaxial connections.

TYPE 250-A FREQUENCY RANGE 500 kc to 250 mc

The RX Meter Type 250-A is a completely engineered measuring instrument including a broad band RF oscillator, RF bridge and null detector. The parallel resistance and parallel capacitance or inductance of the unknown is indicated on precise, easily-read dials. Components such as resistors, capacitors or coils, are connected across two unbalanced binding post connections on top of the instrument. The Co-ax Adapter Type 515-A, shown above, replaces the binding posts in a few seconds with a Type N Connector for measurement of coaxially connected devices. No corrections are necessary over the entire frequency range for most measurements.

Dynamic measurement of a junction transistor under conditions of variable bias and applied RF. Similar procedures can be used with vacuum tubes.

The RX Meter measures the characteristic impedance, attenuation and propagation velocity of RG-58/U Cable.

The RX Meter provides a simple, accurate means of measuring, independently, the RF resistance and reactance of a wide variety of materials, components and circuits. It is also useful in making other types of measurement.

Dynamic measurements of the parameters of transistors and vacuum tubes can be made. D.C. current up to 50 ma can flow through the bridge terminals permitting simple direct biasing of the unknown element. By a simple procedure, the RF voltage across the unknown can also be varied, permitting measurement of input and output impedance under a wide variety of conditions.

Cable characteristics can be measured on the RX Meter using a very short cable sample. A simple measurement will yield the characteristic impedance, attenuation and propagation constant. By the use of a balun the same characteristics can be measured for balanced cables.

SPECIFICATIONS

FREQUENCY RANGE: 500 KC to 250 MC in eight ranges.
FREQUENCY ACCURACY: ±1%.
RESISTANCE RANGE (Rp): 15 to 100,000 ohms.
CAPACITANCE RANGE (Cp): −100 mmf to +20 mmf (may be extended).
INDUCTANCE RANGE (Lp): 0.001 uh to 100 mh.
TEST VOLTAGE: 0 volts D.C. (Up to 50 ma may be passed through unknown terminals). 0.1–0.5 volts R.F. (may be conveniently reduced to 20 mv).
POWER REQUIREMENTS: 105-125 volts, 50/60 cps, 60 watts (internally regulated).

Type 250-A Price: $1320.00 F.O.B. Boonton, N. J.
Type 515-A Price: $35.00 F.O.B. Boonton, N. J.

BOONTON RADIO Corporation
BOONTON·N·J·U·S·A·

BOOST PRODUCT EFFICIENCY *and* SALES APPEAL...

Sturdy little Stackpole Slide Switches provide almost any desired switching arrangement at rock-bottom cost. Features include ½, 1 and 3 ampere 125 volt ratings in U.L. Inspected types; 1 to 3 pole types with up to 4 positions; momentary or maintained contact designs; lug, printed wiring or wire-wrap terminals; and many special types such as plunger-operated spring return, 4-gang SP-DT, and many more.

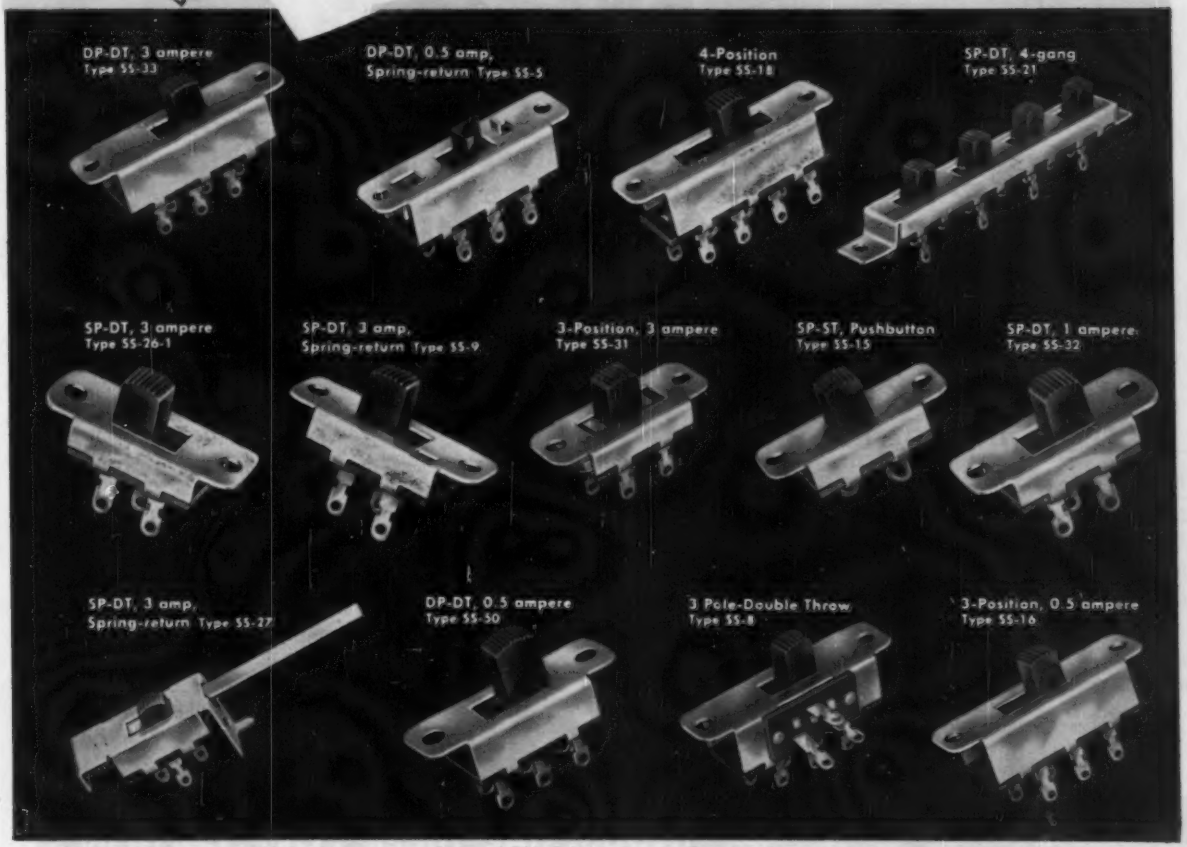
WRITE FOR SLIDE SWITCH BULLETIN RC-11D to:
Electronic Components Division, STACKPOLE CARBON CO., St. Marys, Pa.

...WITH

13 Standard LOW COST TYPES

...the most complete line

STACKPOLE SLIDE SWITCHES



Coldite 70+® fixed composition resistors • Snap and Slide Switches • Ceramag® ferromagnetic cores • Variable composition resistors Ceramagnet® ceramic magnets • Fixed composition capacitors • Iron cores • Brushes for all rotating electrical equipment • Electrical contacts • Hundreds of related carbon, graphite and metal powder products.

Timers for Automatic Control ...Standard or Special?

You'll get quick deliveries from Industrial Timer

If slow deliveries of timers have been delaying you in your automatic control projects, try us! True, your problem may be different and difficult indeed, for no two automatic control jobs are exactly alike. But our record in helping out in situations like these is excellent. For in this field we have a valuable background, twenty years of timer experience to be exact, that has provided us with the special knowledge required to supply our customers with the right answers.

How do we do it? The answer is in what we believe to be the largest variety of standard and combination timer units anywhere in the industry. To fill the widely varying needs of our customers, we manufacture a complete line of timers in the four broad classifications illustrated above: Time Delay Timers, Re-Cycling Timers, Interval Timers, and Running Time Meters. From these our timer engineers have developed 20 basic types which they have so far combined in over 1000 different ways. Therefore—many jobs that would seem to require a special timer, are in fact, a standard timer with us.

And our large stock assures you of rapid deliveries—even when we have to create a brand new timer for your special needs. So why not send us your specifications. You'll get a prompt reply and you may save yourself much lost motion.

AFFILIATE—LINE ELECTRIC COMPANY

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

1409 McCARTER HIGHWAY, NEWARK 4, N. J.

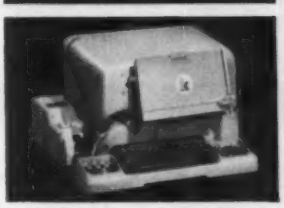
Communications keyed to the jet age

At U. S. Air Force bases of operation, Kleinschmidt page printers and reperforator teletypewriters receive and transmit printed messages at speeds up to 100 words per minute.

Instant and precise communications between Air Force bases is a prime requisite in this era of supersonic speeds. To meet this essential need, Kleinschmidt teletypewriters and related equipment, developed in cooperation with the U. S. Army Signal Corps, provide fast transmission and receipt of printed communications. There is no time-lag for interpretation, no chance of misunderstanding, since both sender and recipient have identical printed originals . . . instantly.

Research and development of equipment for transmitting and receiving printed communications has been a continuing project at Kleinschmidt for almost 60 years. This unparalleled store of experience, now joined with that of Smith-Corona Inc, holds promise of immeasurable new advances in electronic communications.

Model 150 Page Teleprinter
Transmits and receives teleprinted messages at pre-set speeds of 60, 66, 75 or 100 words per minute. Uses roll or fanfold paper. "Semi-rev" operation, whereby shafts rotate only a half-revolution, reduces maintenance, prolongs life of unit.



Model 120 Typing Reperforator—Tape Transmitter
This versatile unit receives and transmits messages in perforated tape form and permits reproduction, editing and preparation of tape, as well as manual keyboard transmission.

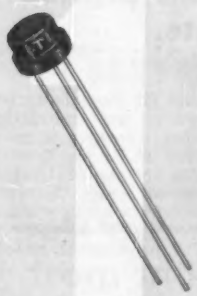
KLEINSCHMIDT

DIVISION OF SMITH-CORONA MARCHANT INC., DEERFIELD, ILL.

Pioneer in teleprinted communications systems and equipment since 1911

Transitron announces

5 NEW TYPES OF SILICON TRANSISTORS

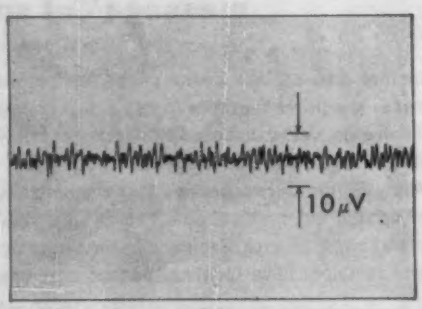


LOW NOISE type... *lowest noise figure yet achieved*

in the critical range from one cycle per second to audio frequencies. The ST1050 offers improved equipment stability down to a fraction of a cycle per second. Use it for all low level amplification problems having an input source impedance of 50 Kohms or less . . . strain gages, thermocouples, accelerometers.

TYPE	ST1050	
Equivalent Input Noise Voltage (0.8 to 50 cps)	2.5	μV RMS
DC Beta @ I_C = 20μa	20	—
Collector Cutoff Current (25°C, −3V)	.002	μa
Collector Cutoff Current (100°C, −3V)	0.2	μa

Complete data in bulletin TE-1353

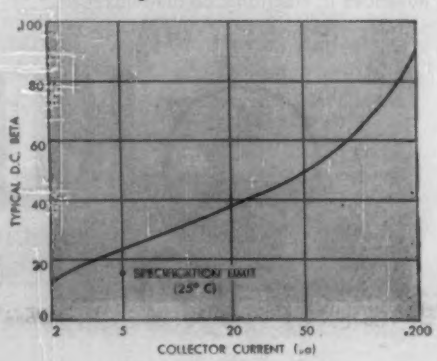


LOW LEVEL INPUT type... *extremely low drift*

over the recommended operating range of 2-200 μa collector current. With typical drift of only 1.0 milli-microamps per degree C and 5 milli-microamps per day, ST1026 may be used in circuits with high impedance sources . . . phototubes, G-M tubes, infra red tubes and ionization gages. Many new low current applications are opened up by the high beta and extremely low I_{co}.

TYPE	ST1026	
Minimum DC Beta @ 5 μa	15	—
Maximum Collector Cutoff Current (25°C, −3V)	.005	μa
Typical Collector Cutoff Current (100°C, −3V)	0.2	μa

Complete data in bulletin TE-1353



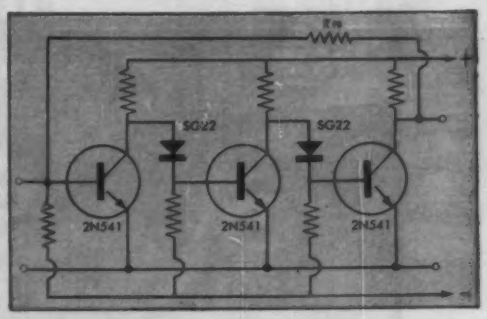
CIRCLE 22 READERS SERVICE CARD

HIGH BETA types... *current gain of 80 minimum,*

the highest level yet achieved in the industry. A useful end-of-life beta is maintained at temperatures down to −65°C, even at reduced collector current levels. The high gain of these transistors reduces the number of stages required in amplifier applications. A greater degree of degenerative feedback may be used to obtain much greater gain stability and uniformity, resulting in *reliable* amplifier operation.

TYPES	2N543	2N542	2N541	
Minimum Common Emitter Current Gain @ 1 Kc	80	80	80	—
Typical Common Emitter Current Gain @ 1 Mc	15	15	15	—
Maximum Collector Voltage	45	30	15	Volts
Maximum Collector Cutoff Current (25°C @ V_c Max.)	.5	.5	.5	μa

Complete data in bulletin TE-1353



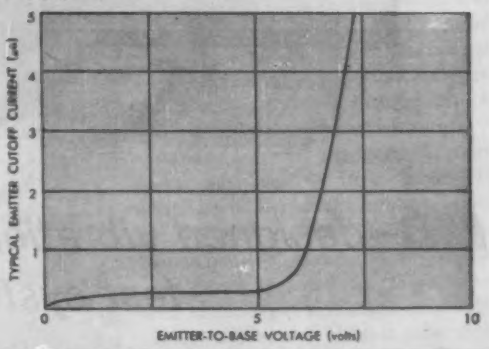
HIGH V_{EB}/SMALL SIGNAL types

... V_{EB} of 5 Volts minimum

eliminates the need for series diodes in many applications and protects against transients in pulse and digital circuitry. This improvement in emitter-to-base voltage is available in Transitron's entire line of small signal transistors, at no sacrifice of other characteristics.

TYPES	2N543A	2N480A	2N475A	
Maximum Emitter-to-Base Voltage	5	5	5	Volts
Maximum Collector Voltage	45	45	45	Volts
Minimum Common Emitter Current Gain	80	40	20	—
Maximum Collector Cutoff Current (@ V_c = 45 Volts)	.5	.5	.5	μa

Complete data in bulletin TE-1353



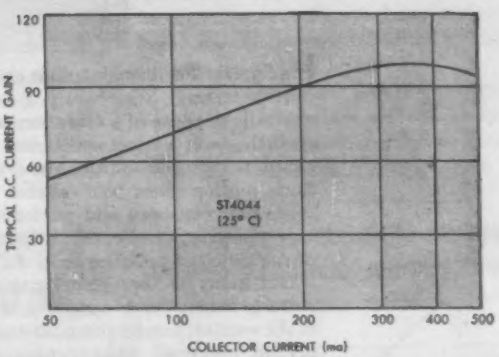
HIGH BETA/MEDIUM POWER types

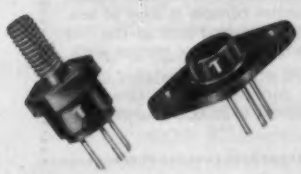
... current gain of 40 minimum

at 500 milliamps. Typical power gain of 1000 into a 100 ohm load significantly reduces drive power requirements. When used in conjunction with small signal high gain types, these transistors reduce the number of components needed in a system and, hence, the overall weight and volume. I_{co} is measured at maximum rated collector voltage at 150°C.

TYPES	ST4044	ST4045	
Minimum DC Beta = 40 at I_c	500	200	ma
Maximum Collector Voltage	60	60	Volts
Power Dissipation (100°C, free air)	6	.6	Watt
Power Dissipation (100°C, stud heat sink mounting)	5	5	Watts
Typical Collector Saturation Voltage (@ specified current)	3	1.5	Volts

Complete data in bulletin TE-1355





HEAT SINK MOUNTINGS... *higher power ratings*

for medium power transistors in Transitron's TO-5 Outline package. These factory-fitted heat sink mountings make possible a realistic 5 watt rating at 100°C case temperature for the first time. The stud type offers the convenience of single-hole mounting, the same as for our JAN rectifiers in the 7/16" hex package. No clip is needed . . . insulation and mounting hardware are supplied. Complete data in bulletin TE-1355.

Transitron

electronic corporation • wakefield, massachusetts

Transistors Diodes Regulators Rectifiers

CIRCLE 23 READERS SERVICE CARD

MB-designed vibration test systems give

high performance table motion

It's *System Performance* that counts most in vibration testing.

Whole purpose of a vibration test system, large or little, is to subject specimens to *motions* that simulate service conditions as closely as possible. Such motion gives you *reliable* information on vibratory response and performance of structures, products, components. It helps reduce risk of malfunction or failures in the field.

But many factors contribute to this motion. Among them: force output and characteristics of the exciter; ample and undistorted power supply to meet all shaker-plus-specimen load relationships; meticulous matching of components in the entire system from input signal to output at the shaker table.

INTEGRATED SYSTEM OFFERS OPTIMUM RESULTS

As the manufacturer of *complete* systems, MB intimately knows the operational needs of shaker, builds amplifiers and controls around those needs. Each MB system is integrated toward the highly desired end result . . . *delivering optimum performance at the shaker table* for present and future needs.

The largest field service organization in vibration testing is ready to help you achieve that result. For latest information, call on MB.

HIGH FORCE HIGH PERFORMANCE SYSTEM

Shown above is a typical MB test system. It includes a Model C70 7000 pound force vibration exciter fit for environmental testing chambers.

The MB T996 amplifier is rated at 50KVA output and can handle the most adverse reactive shaker loads for broad-band sine wave and random motion testing. The T68MC control console is easy to use, also provides automatically cycled testing. The T88 console expands system for complex motion work.

Send for Bulletin 470 which gives detailed specifications on the high performance available from this system; and from others to 25,000 pounds force.

largest producer of complete systems for vibration testing

MB manufacturing company 1075 State Street New Haven 11, Conn.

A Division of Textron Inc.

CIRCLE 24 READERS SERVICE CARD

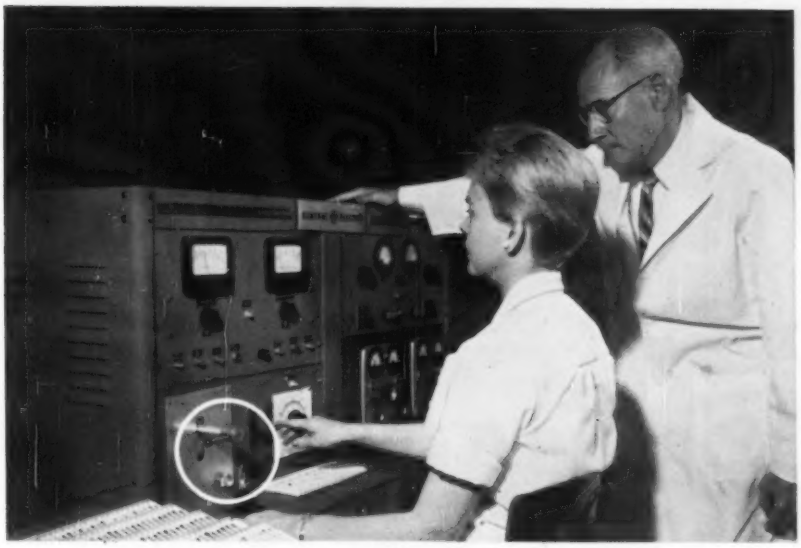
CIRCLE 25 READERS SERVICE CARD→

GENERAL ELECTRIC

TUBE DESIGN NEWS

FROM THE RECEIVING TUBE DEPARTMENT OF GENERAL ELECTRIC COMPANY

New Fast, Sure G-E Impulse Test Method Safeguards 5-Star Tube Performance under Vibration Conditions



IMPULSE-TESTING G-E SUBMINIATURES. R. W. Field, Manager, Finished Tube Quality Control, General Electric Owensboro tube plants, watches test operator take peak and integrated output readings as 5-Star 6111's are tapped by pendulum (circle). To assure accurate readings, the meter pointers remain in indicating position until operator presses the reset button.

Rapidly being applied to 5-Star Tubes — miniatures and subminiatures—General Electric's new impulse test method for measuring vibrational output gives a lower-noise tube in military applications where shock and vibration are definite hazards.

Missile circuits, for example, may incur any one of three kinds of vibration — impulse, random, and periodic. All three can result in tube resonance and variations in output.

In order to weed out those tubes with high output variations caused by vibration, General Electric tube engineers developed a new, fast, and positive method of impulse-testing which interprets tube output in terms of both peak and *integrated* values. Integrated output figures have a close correlation to swept-frequency test results (see chart below).

G.E.'s test thus protects against periodic and random, as well as impulse-type, vibration, insofar as these conditions affect tube performance.

For 6829 5-Star Twin Triode: Most Advanced General-Purpose MIL Tube Spec Ever Written!

Thirty-nine MIL-spec performance tests for General Electric's 6829 military tube are followed by seven different life tests. Important among these is a special cut-off life test to assure emission capabilities after long periods of cut-off operation.

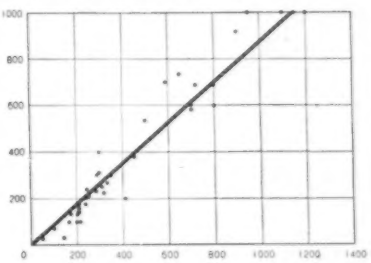
Other 6829 MIL-spec life tests cover: 100-hour survival rate, heater cycling, and a stability check for early-life variations in tube characteristics; also long-term reliability tests conducted under Class-A, zero-bias, and pulse conditions.

Proved by these stringent factory tests, General Electric 5-Star 6829's are going into circuits that demand the utmost in tube reliability.

The 6829 has high perveance; uniform, controlled cut-off; high mu and high transconductance. These custom-fit the tube for use as a counter in computers, or as a line or core driver in cathode-follower circuits.

In addition, the versatile 6829 is directly suited to amplifier or pulse-generator applications in military controls, communications equipment, and detection systems. Ask any General Electric Receiving Tube Department office listed on the following page for additional information!

Showing Close Correlation Between Impulse and Swept-Frequency Tests



Horizontal: integrated output of impulse excitation, in microvolt-seconds. Vertical: swept-frequency vibration (100 to 10,000 CPS, 10 G peak acceleration), max output in peak-to-peak millivolts. Tube tested, Type 6021. 40 sections. E_f:6.3 v, E_b:100 v, R_k:150 ohms, R_l:10,000 ohms.

Tear off and keep this sheet for reference. It contains useful tube-application data.

TO MINIMIZE TV DISTORTION, ALLOW FOR VIDEO REFERENCE SHIFT!

Avoid White Compression and Other Picture Faults by Designing for a Video-Amplifier Grid Voltage Range in Excess of Peak-to-Peak Drive!

Study of the diagram at right will show how essential it is for the television designer to provide a linear transfer characteristic with significantly greater dynamic range than apparently is required for a given peak-to-peak video-detector output. This applies when AC coupling is used between video detector and video amplifier.

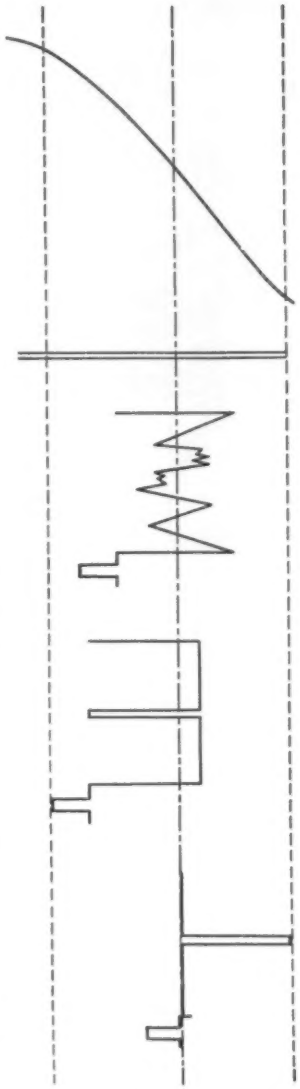
In order to include the two extremes of the picture tone scale—a predominantly white screen image or a predominantly black image—the grid-voltage swing called for is approximately 1.6 times that of the peak-to-peak detector-output voltage.

These two picture extremes are not commonly encountered in home set operation. However, their existence shows that a safety factor should be used when choosing video-amplifier tubes or establishing detector level, in order to assure good picture reproduction over a wide range of image content. The amount of safety factor will depend on the degree of compromise chosen by the designer. A factor between 1.24 and 1.4 times the detector-output voltage might be considered practical.

Tube Characteristics Vital—Select the Right Type!

Depending on individual circuit requirements, the TV designer should carefully consider a video-amplifier tube's cut-off characteristics and amplification factor insofar as these affect the tube's ability to cover the full desired grid-voltage range efficiently.

General Electric's wide selection of video-amplifier types helps the designer choose exactly the right tube for his circuit. Among G-E types are the popular 6AU8-A . . . 6/8AW8-A . . . 6/8CX8 . . . 6/8EB8 . . . 12BY7-A. Ask any G-E receiving tube office below for expert application counsel!



Curve at left plots plate voltage (vertical axis) against grid voltage (horizontal axis) for a video-amplifier tube with typical plate load.

Outer vertical lines show extremes within which constant peak-to-peak drive shifts. Middle line represents bias with no signal.

Average picture: mixed blacks, grays and whites. Waveform represents one horizontal scan line.

Scan line for a predominantly white picture, with vertical black bar at center.

Scan line for a predominantly black picture, with vertical white bar at center.

For further information, phone nearest office of the G-E Receiving Tube Department below:

EASTERN REGION
200 Main Avenue, Clifton, New Jersey
Phones: (Clifton) GRegory 3-6387
(N.Y.C.) Wisconsin 7-4065, 6, 7, 8

CENTRAL REGION
3800 North Milwaukee Avenue
Chicago 41, Illinois
Phone: SPring 7-1600

WESTERN REGION
11840 West Olympic Boulevard
Los Angeles 64, California
Phones: GRanite 9-7765; BRadshaw 2-8566

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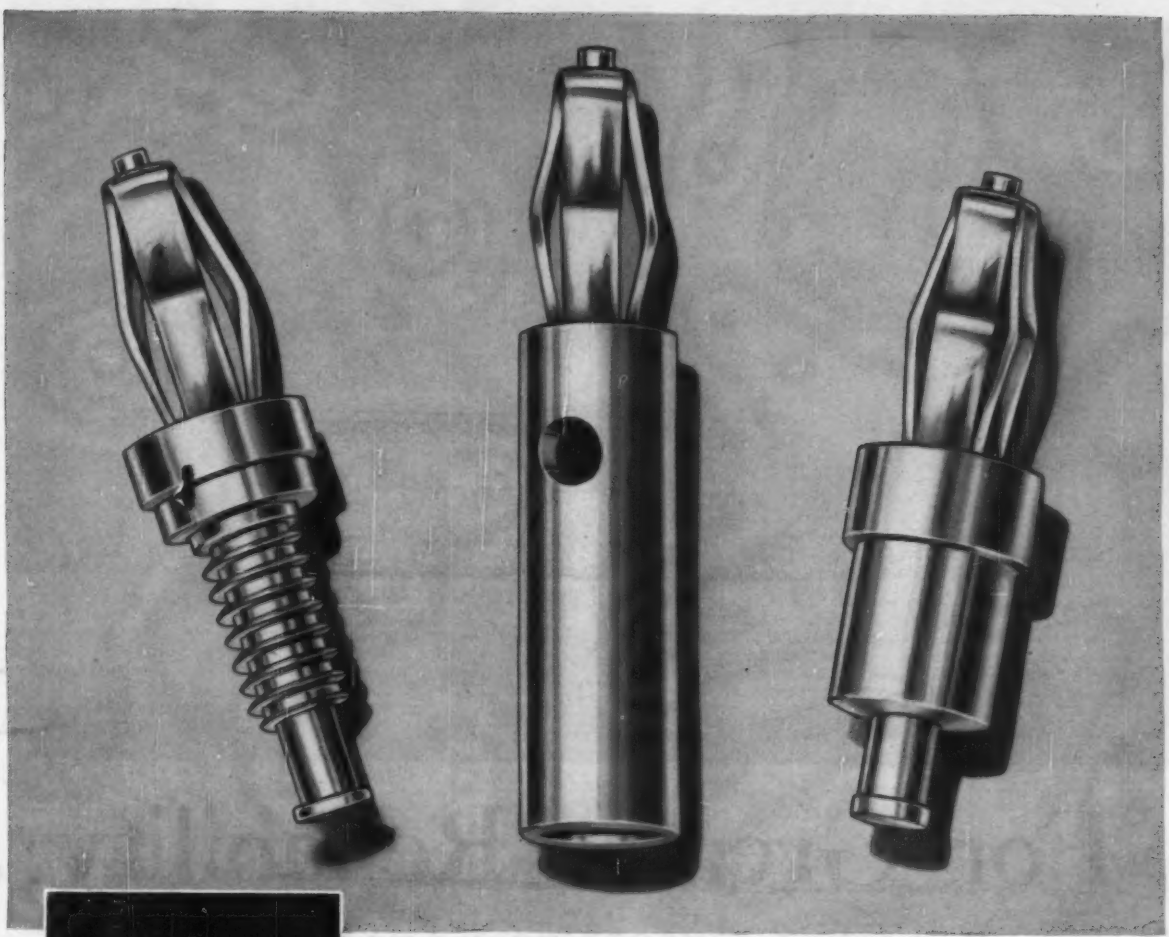
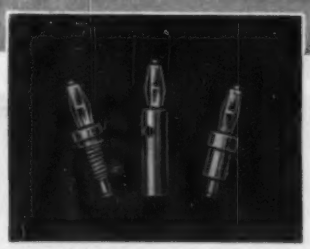
12-11-206



6 times enlargement



Actual size

Ucinite Miniature Banana Pins

Heavy resistance to torque is a big feature of Ucinite miniature banana pins. The springs are mechanically riveted over and the large area around the tip of the pin is bonded by solder.

Pins are available in a variety of types, for assembly by staking . . . with nuts and washers . . . with soldered tails . . . with multiple plug-in features. Springs are designed to fit .093 sockets.

Built to withstand rough usage, Ucinite miniature banana pins are available in cadmium, silver or gold plate.

For further information, call your nearest United-Carr representative or write directly to us.

ELECTRICAL ASSEMBLIES Ucinite RADIO AND AUTOMOTIVE

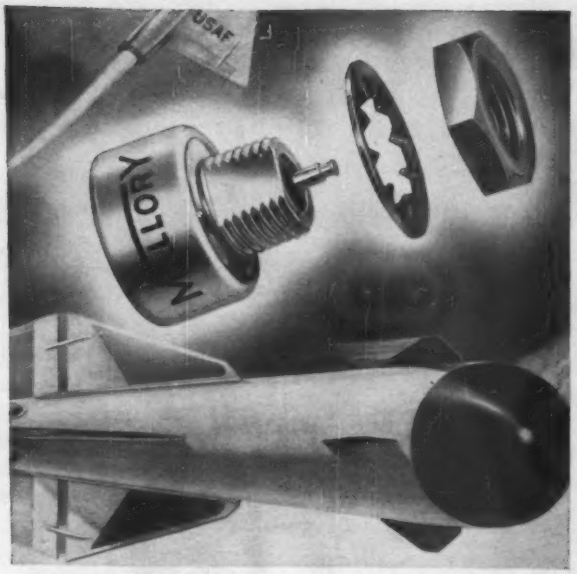
The UCINITE CO.

Newtonville 60, Mass.

Division of United-Carr Fastener Corp.

Specialists in

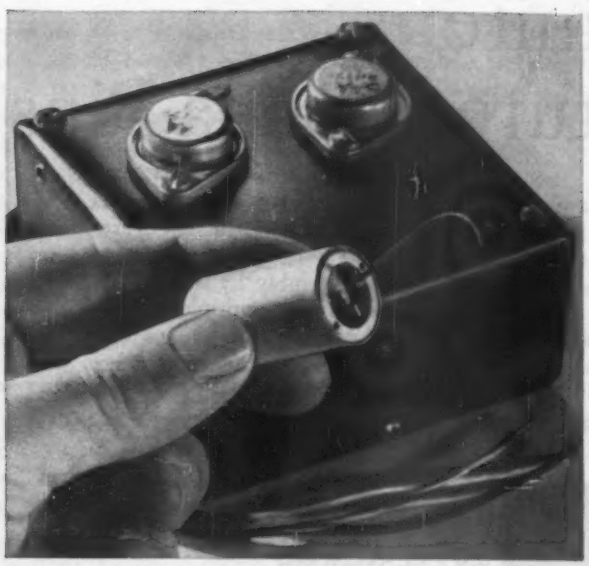
ELECTRICAL ASSEMBLIES, RADIO AND AUTOMOTIVE



High temperature tantalum capacitors, pioneered by Mallory for −55 to +200°C service, include special designs for extreme acceleration. Newest types, such as the M2, TAP2 and others, are even smaller in size—ideal for miniaturized missile-borne telemetering circuits. Mallory also manufactures a complete line of subminiature and solid electrolyte tantalum capacitors.

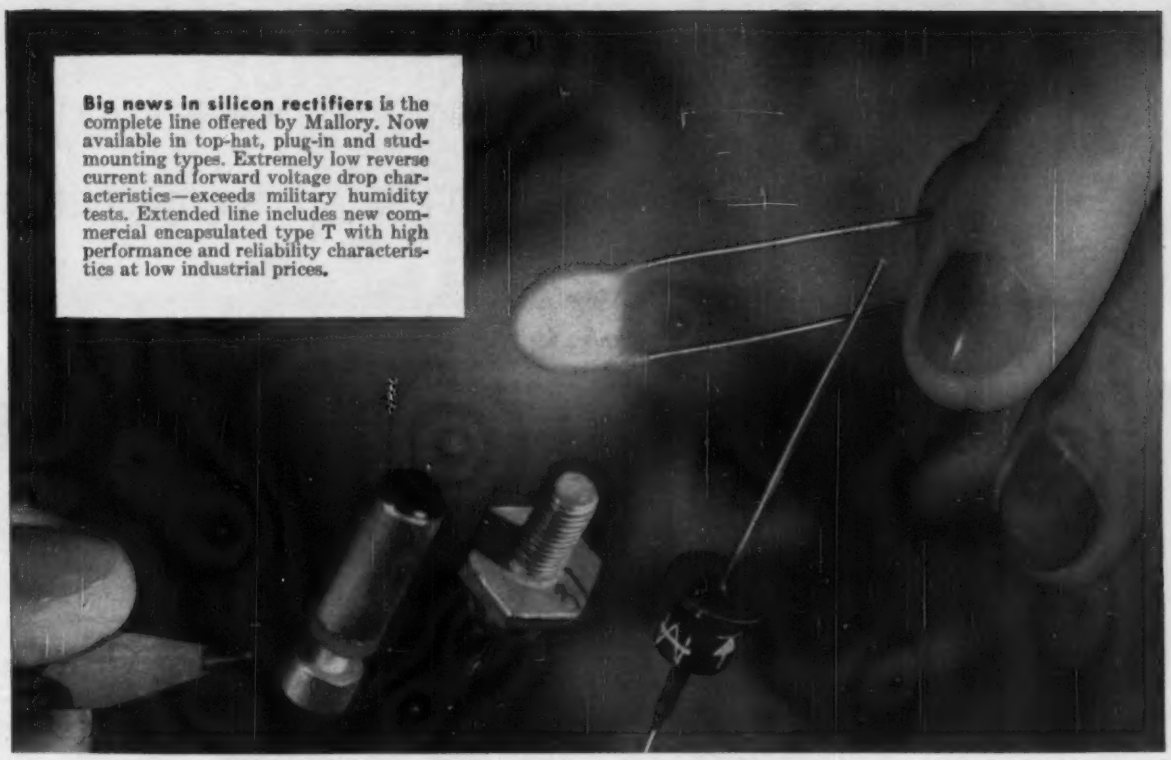
Sub-assemblies made to order, in Mallory's Electronic Assembly Department, Frankfort, Indiana, receive the attention of a skilled staff well experienced in every phase of circuit research, component development, assembly and testing. Now qualified under the U.S. Army Signal Corps Reduced Inspection Quality Assurance Plan (RIQAP), this Mallory department is ready to undertake production of single units or complete systems.

For Greater Reliability...



Miniaturization in power supplies for rocket-borne instrumentation gains further impetus from two new Mallory developments. All-transistor power supply gives exceptional compactness, ruggedness and reliability... high conversion efficiency. New Series 1900 miniature vibrator, only $1\frac{5}{16}$" long and $1\frac{1}{2}$ ounces in weight, uses new design concepts to give extreme resistance to shock and vibration.

New high temperature miniature wirewound control . . . only $\frac{3}{4}$" in diameter, is designed for ambient temperatures of 200°C and up. It has exceptionally high power dissipation for its size—rated 5 watts at 145°C. Control is gold plated to assure maximum shelf life, resistance to corrosion and high heat transfer. Easily adaptable to hermetically sealed mounting.


Big news in silicon rectifiers is the complete line offered by Mallory. Now available in top-hat, plug-in and stud-mounting types. Extremely low reverse current and forward voltage drop characteristics—exceeds military humidity tests. Extended line includes new commercial encapsulated type T with high performance and reliability characteristics at low industrial prices.

• • • *in Missile Guidance Systems*
MALLORY Components and Services

In today's accelerated defense programs, electronic missile guidance systems need an extra measure of dependability in order to perform a critical service at a precise moment. You can build this extra dependability into research circuits, prototypes and production models—when you specify Mallory precision-made components.

When your problems are new or unusual, you can get expert assistance from the experienced Mallory application engineering team. Because of the wide range of components we supply, you can count on us for engineering consultation not only on component design and application, but also in other important areas such as contact metallurgy and sub-assembly manufacturing.

Shown here are just a few of the Mallory products and services that can help put peak reliability in your missile guidance circuitry. It will pay you to check your needs against the broad Mallory line. Write today for a consultation on your specific projects. For prompt delivery of stock components, call on your nearby Mallory distributor.

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Tuning Devices • Vibrators
Electrochemical—Capacitors • Mercury and Zinc-Carbon Batteries
Metallurgical—Contacts • Special Metals • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

Expect more . . . get more from

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MALLORY
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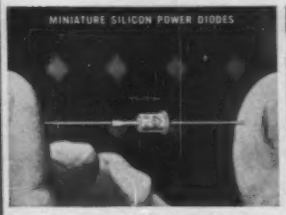
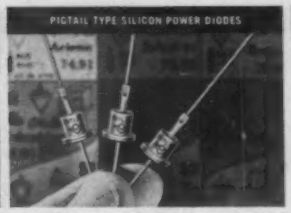
ELECTRONIC TYPES FOR INDUSTRIAL AND MILITARY APPLICATIONS

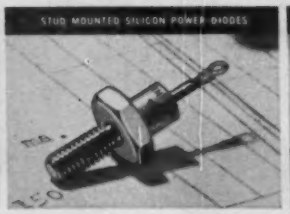
SILICON AND SELENIUM LOW CURRENT TYPES TO 1 AMP.



Ratings: 100 to 600 PIV, Up to 500 ma.
Specifically designed for missile and airborne equipment applications where miniaturization and reliability are prime factors. Hermetically sealed, all-welded, pigtail lead construction. Manufactured to meet the most rigid military requirements. Request **Bulletin SR-203**



Ratings: 50 to 600 volts PIV • 250 to 750 ma.
An extensive line of silicon power diodes for military and industrial applications featuring all-welded, hermetically sealed construction. All designed and manufactured to meet the most rigid military requirements. For information on types for your application **Contact Factory**



Ratings: 50 to 600 volts PIV • 400 ma. to 1 amp.
Industrial and military types including the 1N253, 1N254 and 1N255. Stud mounted, hermetically sealed, all-welded construction. Operating temperature range: −65°C to +150°C. Designed and manufactured to meet most rigid military specifications. **Bulletin SR-135C**

Ratings: 20 to 160 volts • 100μa to 11 ma.
Ideal components for bias supplies, sensitive relays, computers etc. High resistance, (10 megohms and higher at −10 volts). Excellent linear forward characteristics. Extremely small, low in cost. Encapsulated to resist adverse environmental extremes. Specify **Bulletin SD-18.**

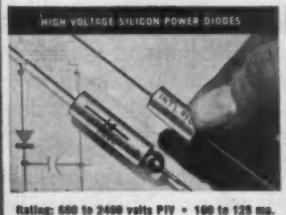
Ratings: From 100 ma. to 50 Amps.
Low forward voltage drop and low leakage characteristics make this series ideal for a wide variety of power applications. For details request **Bulletin C-439,** (26 volt cells); **Bulletin SR-140,** (45 to 52 volts per cell) and **Bulletin SR-132,** on high current density cells.

Ratings: 25 to 156 volts AC, 50 to 1,200 ma. DC
The widest range in the industry! Designed for Radio, Television, TV booster, UHF converter and experimental applications. Input ratings from 25 to 156 volts AC and up. DC output current 50 to 1,200 MA. Write for application information. **Bulletin ER-178-A**

Ratings: 400 PIV, up to 750 ma.
SD-500. A hermetically sealed, all-welded silicon junction rectifier offering maximum reliability in the high temperatures encountered in TV applications. Pigtail leads eliminate the need for brackets, blocks, etc., simplify installation. For complete data: **Contact Factory.**

Ratings: Q of 1000, 200 PIV DC
Semicap's small size, light weight, high reliability and low power requirements make it ideal for automatic frequency control, frequency modulation oscillators and filter networks. All-welded hermetically sealed, shock-proof housing. Request **Bulletin SR-388.**

SILICON AND SELENIUM HIGH VOLTAGE TYPES



Rating: 600 to 2400 volts PIV • 100 to 125 ma.
Three types available. Hermetically sealed, pigtail construction. Style J rated at 600 to 1000 volts PIV at 125 ma. **Bulletin SR-138E** Styles K and L with PIV ratings from 600 to 2400 volts at 100 ma. dc output current are described in technical detail—**Bulletin SR-187.**

Ratings: 1500 to 10,0000 volts PIV @ 45 to 440 ma.
Especially suited for miniaturized military equipment where optimum reliability is a prime factor. Standard types for normal convection cooling and high current types for forced air or oil cooling. Hermetically sealed, metallized ceramic housing. Request **Bulletin SR-225**

Ratings: 20 to 20,000 volts • 0.2 to 195 ma.
Designed for long life and reliability in half-wave, voltage doubler, bridge, center-tap circuits, and 3-phase circuit types. Phenolic cartridges and hermetically sealed types available. Operating temperature range: −65°C to +100°C. For details specify **Bulletin H-2.**

Rating: 12,500 volts PIV at 5 Amps.
Illustrated above is a typical rectifier of advanced design produced by International Rectifier Corporation for military application. Data on ruggedized silicon substitutes for many standard vacuum tubes may be obtained from our Military Products Department.

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The World's Largest Supplier of Industrial Metallic Rectifiers • Selenium • Germanium • Silicon

RECTIFIERS FOR ALL DC REQUIREMENTS...FROM MICROWATTS TO MEGAWATTS!

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LINE OF QUALITY RECTIFIERS ON EARTH!

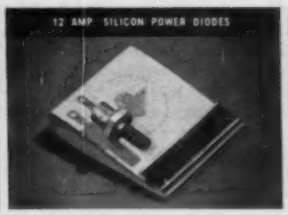
All designed and manufactured to meet the most rigid military requirements!

POWER TYPES FOR INDUSTRIAL AND MILITARY APPLICATIONS

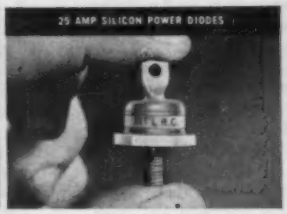
SILICON AND SELENIUM MEDIUM CURRENT TYPES TO 150 AMPS

Utilizing junctions rated to 1.25 amps DC output

These stacks consist of hermetically sealed junction diodes mounted on copper cooling fins, stacked to include the interconnections required for specific circuits. Junction ratings: 1.25 amps. DC output: 70 to 380 AC input volts rms. Request **Bulletin SR-137A**

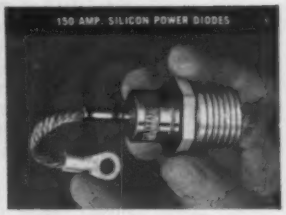


Conservatively rated to provide a substantial safety factor in industrial applications. Hermetically sealed, all-welded case construction provides reliability over a long life. Types available in a wide voltage range. For details **Contact Factory.**



Rating: 50 to 500 volts PIV • 25 to 45 Amps.

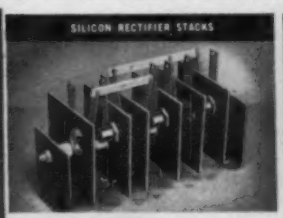
Advanced ceramic techniques assuring excellent thermal characteristics and mechanical stability are used in the production of these highly reliable, hermetically sealed rectifiers for military or industrial applications. For complete technical data, request **Bulletin SR-304**



Ratings: 50 to 800 volts PIV • 45 to 150 Amps.

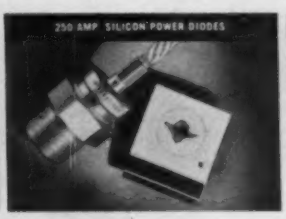
An extensive series of standard and reverse polarity types. Optional mounting bases including machine thread and pipe thread types. Machine thread base types: **Bulletin SR-300,** Pipe thread base types. **Bulletin SR-301,** Complete stack assemblies: **Bulletin SR-302**

SILICON, SELENIUM AND GERMANIUM HIGH CURRENT TYPES TO 670 AMPS PER JUNCTION



Ratings: 45 to 150 Amperes per Junction

Consisting of hermetically sealed junction diodes mounted on aluminum or copper cooling fins, stacked to include the interconnections required for specific circuits. Junction ratings: 45 to 150 amps average DC. Write for application data.

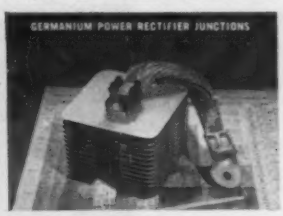


Ratings: 50 to 500 volts PIV • 75 to 250 Amps.

Standard and reverse polarity types offered in a series of machine thread and pipe thread mounting styles. Complete assemblies in all circuit configurations also available. Rugged construction and hermetic sealing assure long life and reliability. Ask for **Bulletin SR-305**

Ratings: 6 to 30,000 volts • 50 to 2,300 Amps.

Specifically designed for industrial DC power needs. Patented construction features assure long life. Descriptive bulletins available are: **Bulletin C-349,** (28 volt cells); **Bulletin SR-140,** (45 to 52 volts per cell) and **Bulletin SR-132,** on high current density cells.



Ratings: 800 amperes • 26 to 68 volts rms

High capacity junctions especially designed for high-current, low-voltage electrochemical installations. Air cooled, these hermetically sealed junctions provide efficiency to 98.5%. Cast aluminum airfoil housing effects maximum heat transfer. For details **Contact Factory.**

SPECIAL SEMI-CONDUCTOR DEVICES

Complete series of AC and DC types.

Designed to eliminate arcing and erosion across the contacts of relays, switches, etc. A complete series in each of three basic types: diode type, cartridge type and hermetically sealed types for industrial application. For complete data: **Bulletin SR-150-A**

Ratings: From 600 milliwatts to 10 watts

A complete series in 6 types. Miniature single junction types, multiple junction types and double anode units. 750 milliwatt and 1 watt types: **Bulletin SR-251,** 3.5 and 10 watt types: **Bulletin SR-252,** Multiple junction 5 watt types: SR-253, Double anode types: SR-254

Temperature compensated for stability to ±.001% °C

Extremely precise units for power supplies and voltage sources. Temperature compensated for excellent stability over a temperature range of from -55°C to +150°C. Manufactured to meet the most rigid military requirements. Types 1N430, 1N430A, 1N430B. **Bulletin SR-235**

(Wide range of silicon and selenium types.)

Self-generating cells available in standard and custom sizes, mounted or unmounted. For details on wide selection of selenium types, request **Bulletin PC-649.** Silicon solar cells in mounted and unmounted types are described in technical detail—specify **Bulletin SR-156.**

Rectifier Corp.

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HICAGO AREA OFFICE: 205 W. Wacker Dr., FRanklin 2-3888
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SPERRY INTRODUCES...

New portable radar safety meter for survey of microwave power fields

Like many technical developments, the high-power microwave systems now coming into wide military use present an unexpected problem. Medical and military leaders alike are concerned with the safety of personnel working with these "super radars" which generate tremendous microwave energy fields in their transmitters and antennas.

Current information indicates the surest methods for establishing safe working conditions near powerful microwave devices involve survey measurements of microwave power density in the area. But, until now, application of this principle has been restricted because engineers have lacked suitable portable equipment for making these measurements.

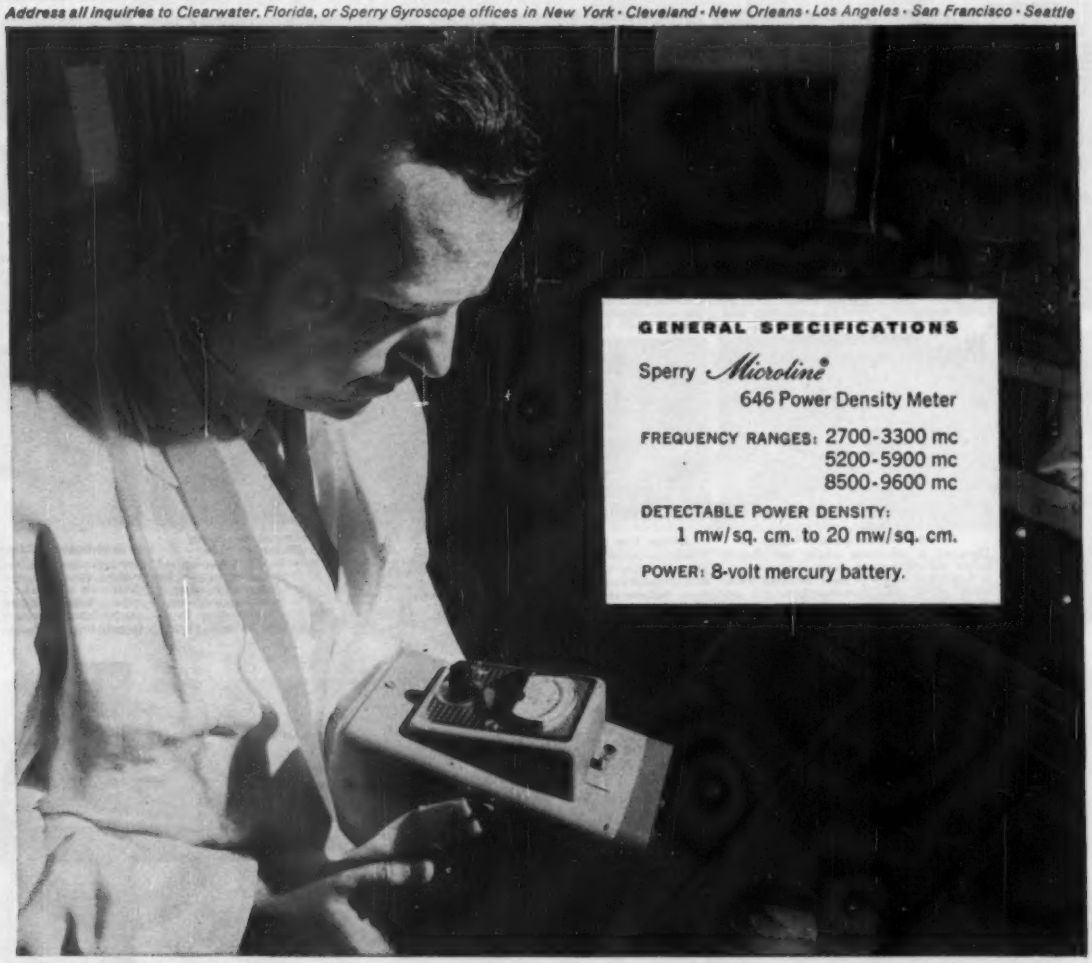
As a leading producer of advanced radar systems, Sperry has devoted extensive research to the problem of assuring safety in their operation. Result of this investigation is the new Microwave Power Density Meter. Weighing only 6 pounds, the meter provides a simple but highly accurate method of exploring the existence of concentrated energy or "hot spots" close by high-power microwave antennas, transmitter tubes and plumbing. It is completely portable and contains its own power supply.

Utilizing the presently accepted safe energy level of 10 mw/cm², the Sperry meter quickly registers the relative power density above or below the acceptable level. The meter is scaled to read in mw/cm². A single knob operates the meter, permitting its use by nontechnical personnel.

If you'd like more information about the new Sperry Microwave Power Density Meter, write for Microline 646 data sheet.

SPERRY

SPERRY MICROWAVE ELECTRONICS COMPANY, *CLEARWATER, FLORIDA · DIVISION OF SPERRY RAND CORPORATION*
Address all inquiries to Clearwater, Florida, or Sperry Gyroscope offices in New York · Cleveland · New Orleans · Los Angeles · San Francisco · Seattle



GENERAL SPECIFICATIONS

Sperry *Microline*®
646 Power Density Meter

FREQUENCY RANGES: 2700-3300 mc
5200-5900 mc
8500-9600 mc

DETECTABLE POWER DENSITY:
1 mw/sq. cm. to 20 mw/sq. cm.

POWER: 8-volt mercury battery.

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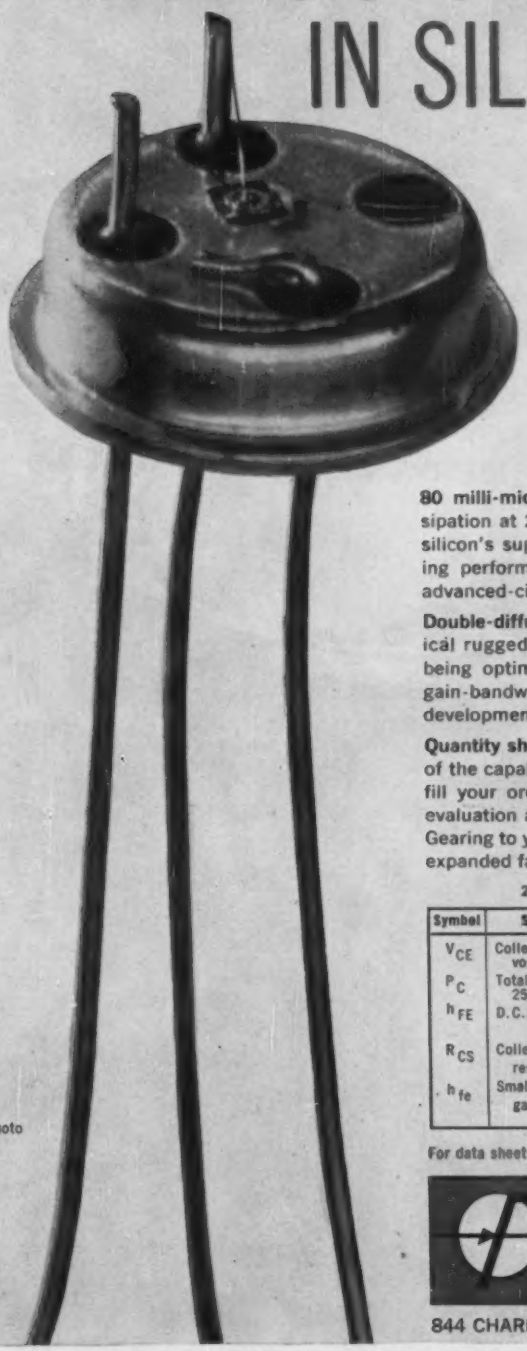
FROM FAIRCHILD

MESA TRANSISTORS IN SILICON



Greatly enlarged photo of Fairchild 2N696 before capping

80 milli-micro-second rise time with 2 watts power dissipation at 25° C. This speed and power is combined with silicon's superior high-temperature reliability. The switching performance that this affords has a place in every advanced-circuit evaluation program.

Double-diffused mesa-type construction provides mechanical ruggedness and excellent heat dissipation besides being optimum for high-frequency performance (typical gain-bandwidth product 80 Mc). This type is under intense development everywhere. Fairchild has it in production.

Quantity shipments now being made give conclusive proof of the capabilities of Fairchild's staff and facilities. We can fill your orders promptly. You can start immediately on evaluation and building of complete prototype equipment. Gearing to your future production needs, Fairchild will have expanded facilities to over 80,000 square feet by early '59.

2N696 and 2N697 — NPN SILICON TRANSISTORS

Symbol	Specification	Rating	Characteristics	Test Conditions
V_{CE}	Collector to Emitter voltage (25° C.)	40v		
P_C	Total dissipation at 25° C. Case temp.	2 watts		
h_{FE}	D.C. current gain		2N696—15 min. 2N697—30 min.	I_C=150ma V_C=10v
R_{CS}	Collector saturation resistance		6Ω typical 10Ω max.	I_C=150ma I_B=15ma
h_{fe}	Small signal current gain at f=20Mc		4 typical	I_C=50ma V_C=10v

For data sheets, write Dept. A-11

FAIRCHILD SEMICONDUCTOR CORPORATION

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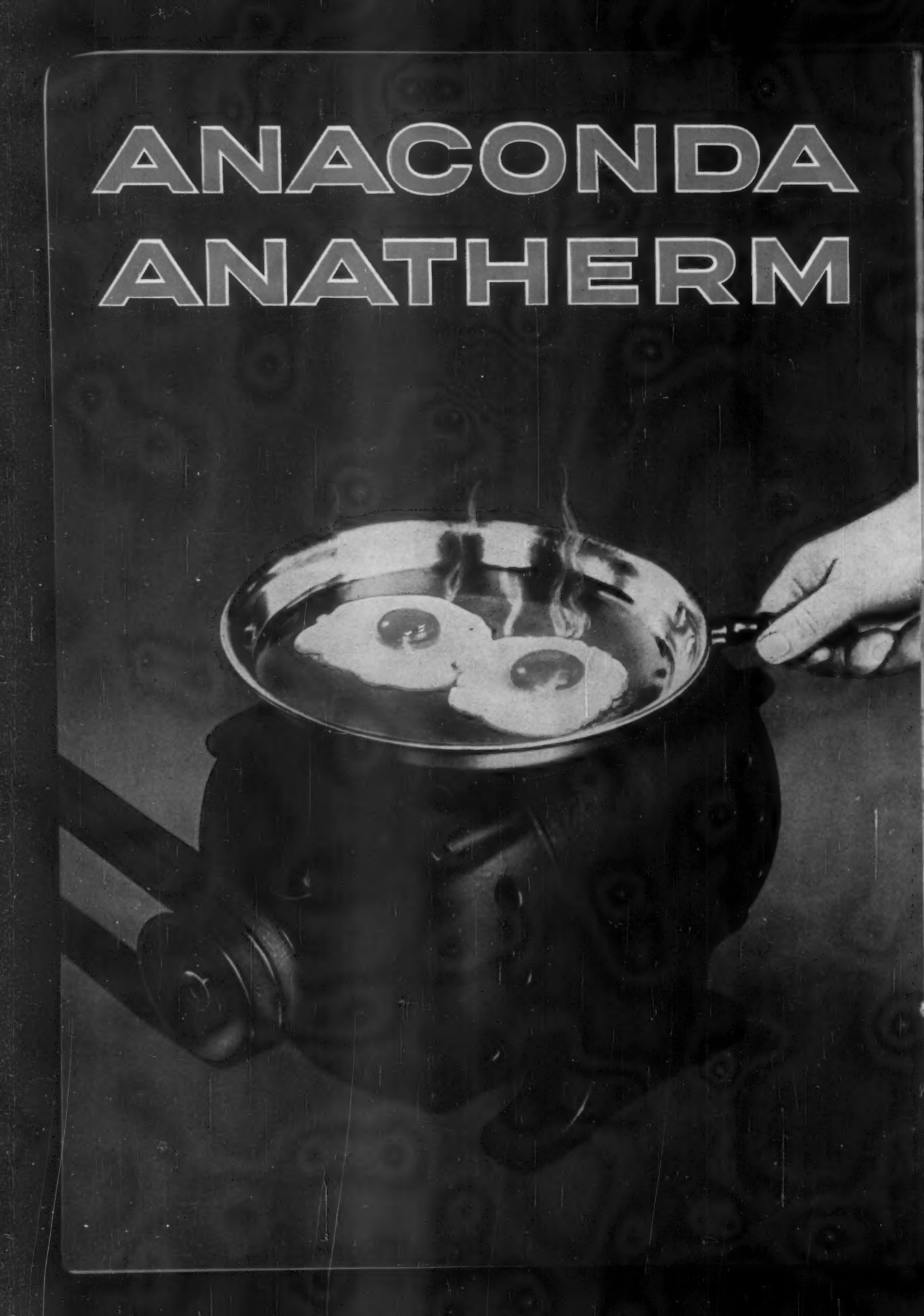
CIRCLE 34 READERS SERVICE CARD →


ANACONDA
ANATHERM

First polyester high-temperature magnet wire in full range of sizes

— — ROUND

— — SQUARE

— — RECTANGULAR

Anatherm, Anaconda's Class 155°C polyester film-coated magnet wire is now available in single, heavy, triple and quadruple grades of round wires (sizes 8 through 46) *and* in a full range of sizes of squares and rectangulars. This is the first time a complete range of sizes and shapes has been offered in this type wire.

Fully tested for use at temperatures up to 155°C, Anatherm was also the first film-coated wire to meet the newly adopted AIEE 155°C (Class F) rating.

Anatherm gives you greater thermal stability—plus excellent abrasion-resistance, chemical stability and dielectric strength. Thus Anatherm is ideally suited for manufacturers seeking maximum performance and reliability from smaller and smaller equipment operating at higher and higher temperatures.

As a polyester magnet wire, Anatherm can be used equally successfully at any "hottest-spot" temperatures over the range of 105°C to 155°C. If you're on the spot about high-temperature magnet wire, ask the Man from Anaconda about Anatherm.

Write for free Anatherm technical bulletin: Anaconda Wire & Cable Co., 25 Broadway, New York 4, New York.

58304

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SEE THE MAN FROM **ANACONDA**®

FOR ANATHERM MAGNET WIRE

FROM ANACONDA...THIS WIDE VARIETY OF TOP-QUALITY MAGNET WIRES—

ANALAC (Class A–105 C)
solderable magnet wire

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PLAIN ENAMEL (Class A–105 C)
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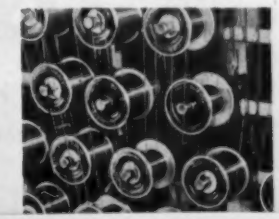

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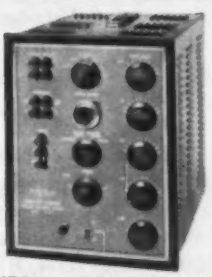

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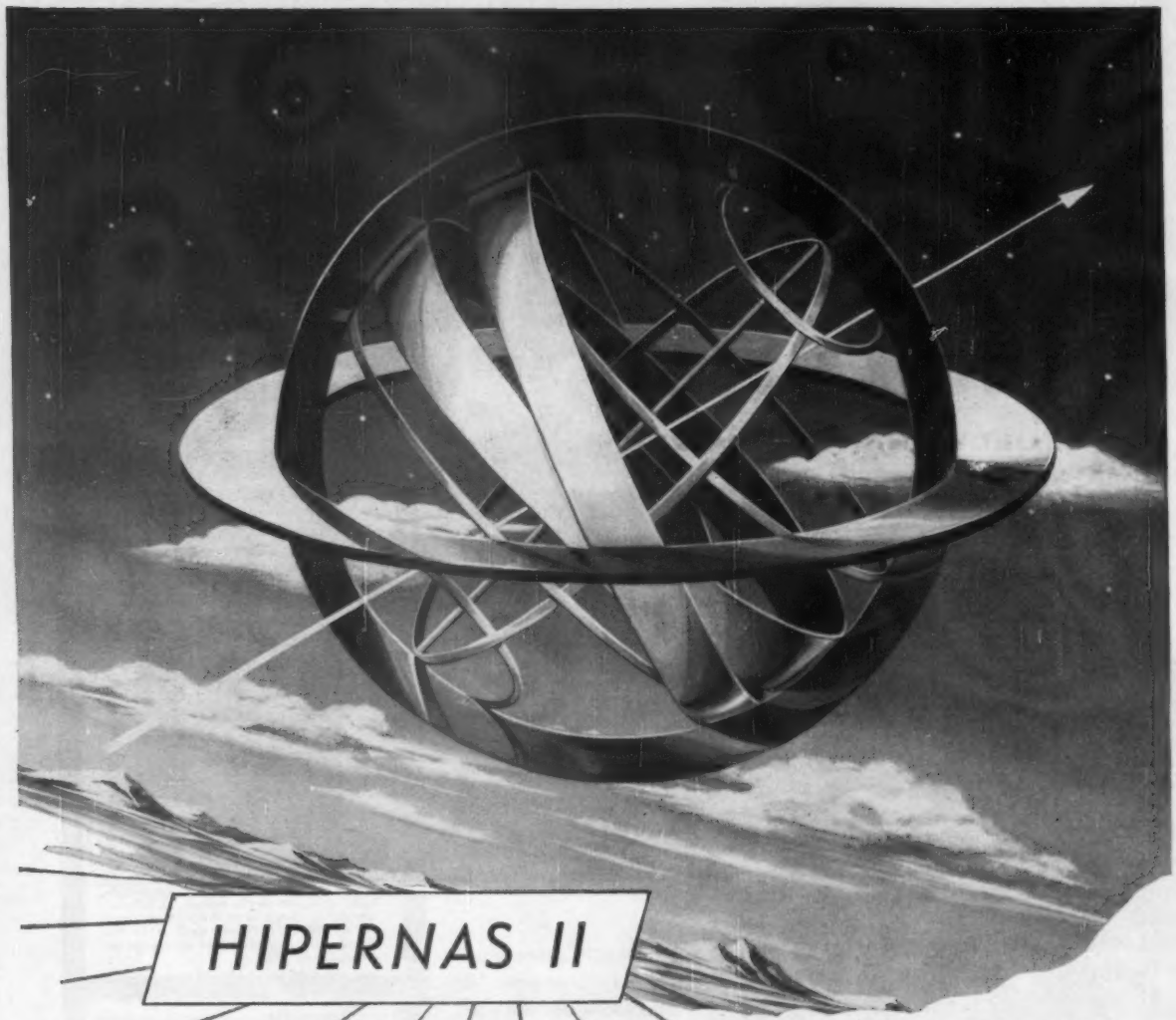

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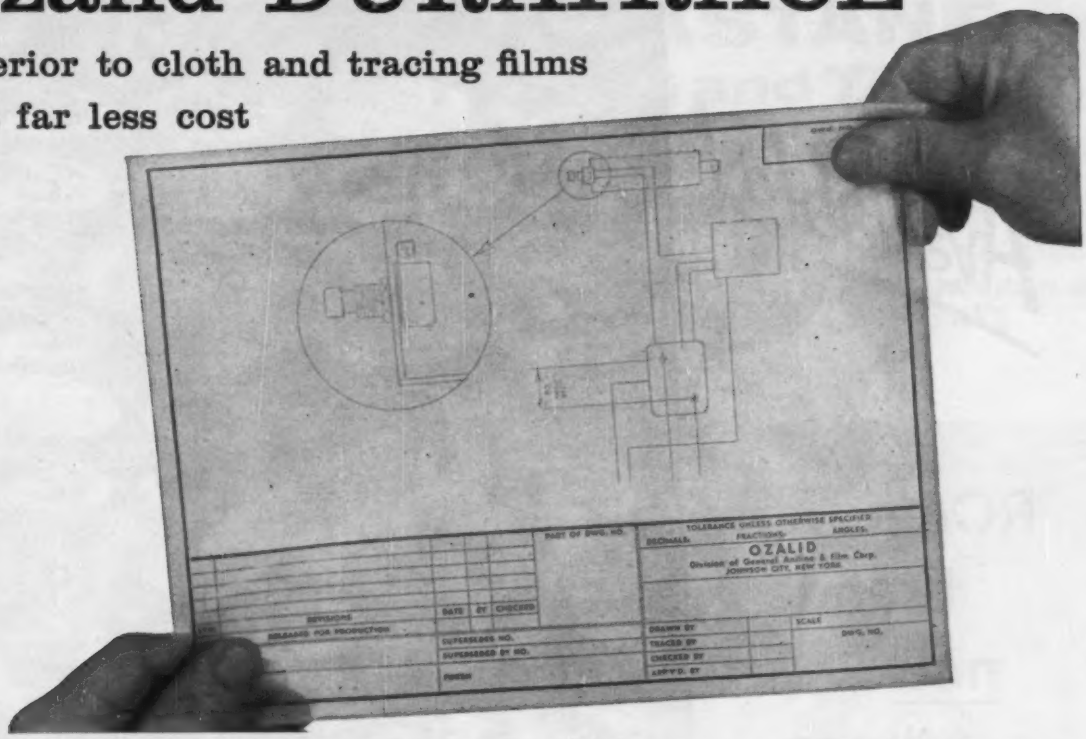

Extremely durable, practically ageless—that's new Ozalid Duratrace drafting film. Duratrace speeds drafting operations, insures greater accuracy and finer prints. Its base is MYLAR* polyester film—the toughest film ever made. It can be used under all climatic conditions and will still maintain its exceptionally high-dimensional stability.

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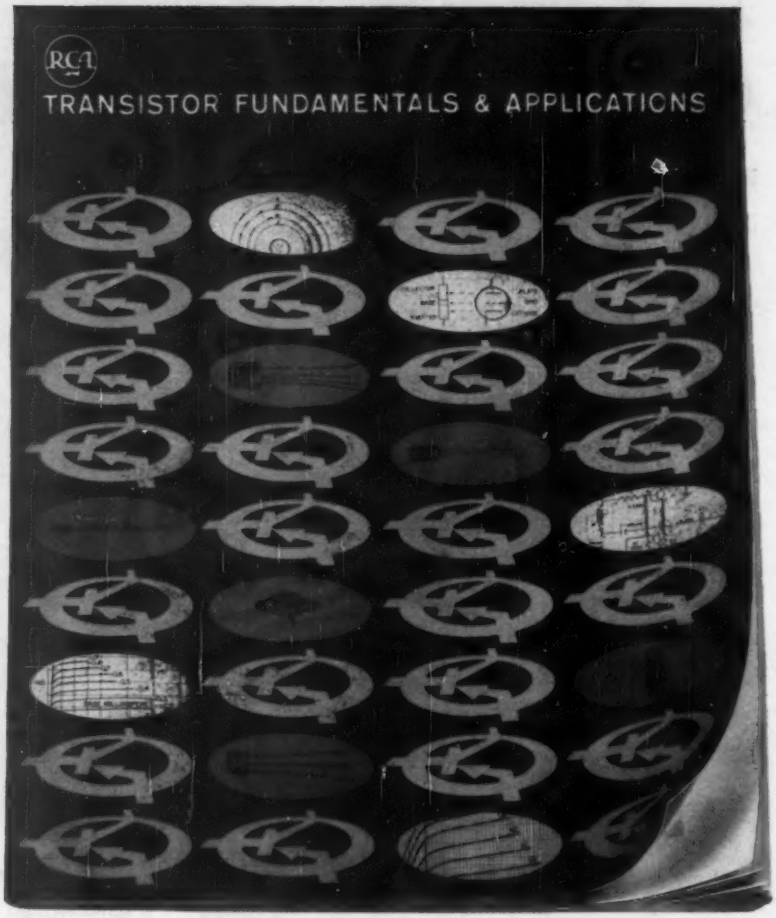

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7—*Types of Transistors*
8—*Transistor Amplifiers*
9—*Methods of Coupling*
10—*Gain Controls*
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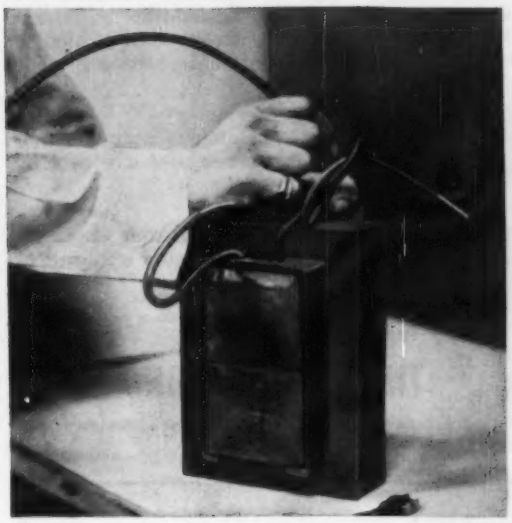

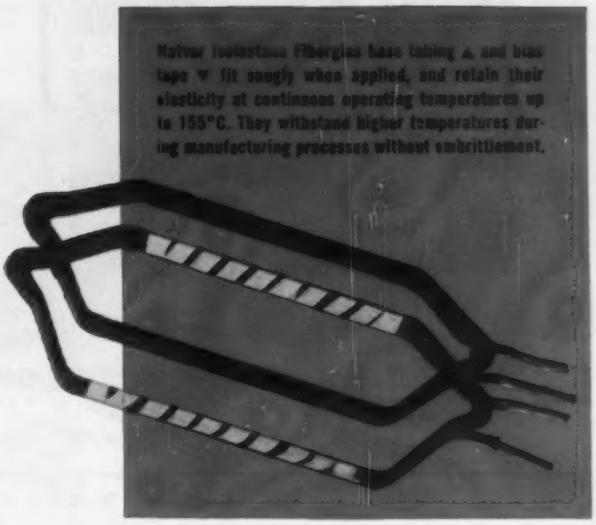

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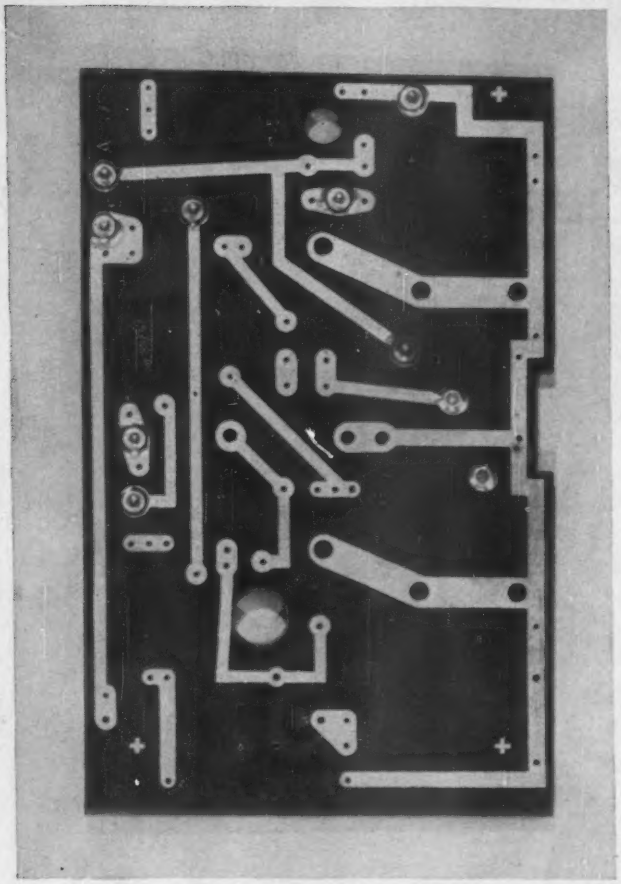

How CDF Di-Clad† can solve your printed-circuit problems

The CDF line of copper-clad laminates in all grades is now known by a new name—Di-Clad. Di-Clad grades meet the varying needs of design, production, and operation of electronic equipment. Grades other than those described are also available.

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Di-Clad 2350. An economy paper-base phenolic grade having good tensile, flexural, compressive, and impact strength. Adequate for most non-critical printed-circuit applications. Can be cold punched and sheared up to 5/64 of an inch in thickness.

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	Di-Clad 2350	Di-Clad 26 (NEMA XXXP)	Di-Clad 28 (NEMA XXXP)	Di-Clad 28E (NEMA G-10)	Di-Clad 112T Teflon*
BOND STRENGTH—0.0014" foil (lbs. reqd. to separate 1" width of foil from laminate)	6 to 10	6 to 10	6 to 10	8 to 12	4 to 8
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (Deg. C.)	120	120	120	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil for 1/16" thickness)	800	900	850	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C. & 90% RH (ASTM D257, Fig. 3)	500	150,000	600,000	100,000	75,000
DIELECTRIC CONSTANT 10^6 Cycles	4.5	4.0	3.6	4.9	2.6
DISSIPATION FACTOR 10^6 Cycles	0.040	0.026	0.027	0.019	0.0015
ARC-RESISTANCE (Seconds)	5	10	10	130	180
TENSILE STRENGTH (psi.)	18,000	16,000	12,000	48,000	23,000
FLEXURAL STRENGTH (psi.)	27,000	21,000	18,000	70,000	13,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.80	0.45	0.42	12.0	6.0
COMPRESSIVE STRENGTH flatwise (psi.)	32,000	28,000	25,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Paper	Paper	Paper	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural	Natural greenish	Natural	Natural	Natural

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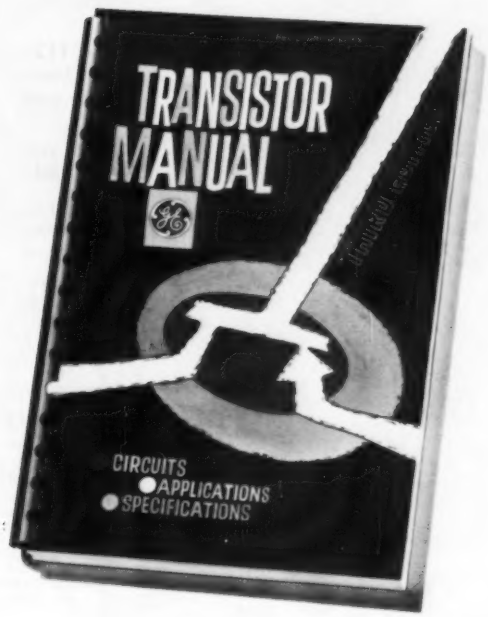
GENERAL ELECTRIC TRANSISTOR MANUAL

Greatly expanded 3rd edition contains latest applications, circuit diagrams and specifications



Never before has so much vital information about transistors — facts you'll use every day in your work — been gathered between the covers of one book!

Whether you're looking for basic information like how to interpret parameter symbols, or are about to design a complex switching circuit, you'll find what you need in General Electric's big new Transistor Manual.

Throughout its more than 160 pages are described the very latest advances in the art of transistors and rectifiers. There are 50% more pages . . . expanded applications sections including new Unijunction Transistor circuits and transistor switches, including Flip-Flop Design Procedures . . . all the latest G-E transistor specifications . . . a list of over 175 new Registered JETEC specs with interchangeability information . . . many new circuits, . . . and a new circuit index to make them easy to find. There's a chapter on General Electric's revolutionary new silicon controlled rectifier, a device which opens up whole new fields of application for semiconductors, but is still so new you won't find it in any other reference.

The General Electric Transistor Manual is already the most widely used book in the transistor field. You won't want to miss this tremendously improved new 3rd edition. Your G-E Tube Distributor has copies now, or mail the coupon on the reverse side with one dollar.

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NEW GENERAL ELECTRIC TRANSISTOR MANUAL

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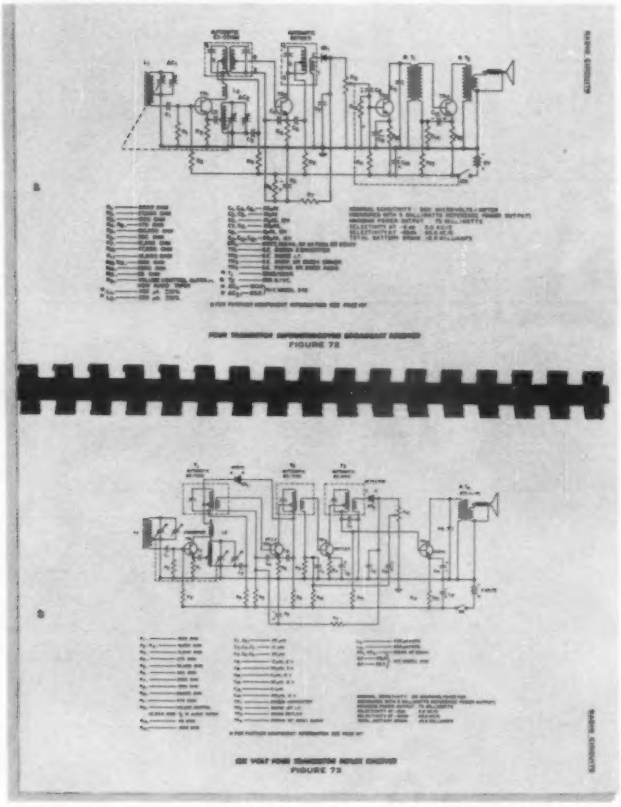

In the fabulous field of semiconductors, with new products coming onto the market almost every day, there is an urgent and continuing need for sound, basic information. As part of OPERATION UPTURN, we offer the expanded new 3rd edition of the Transistor Manual in the hope it will increase understanding and use of transistors and help build sales and jobs in '58.

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BIASING

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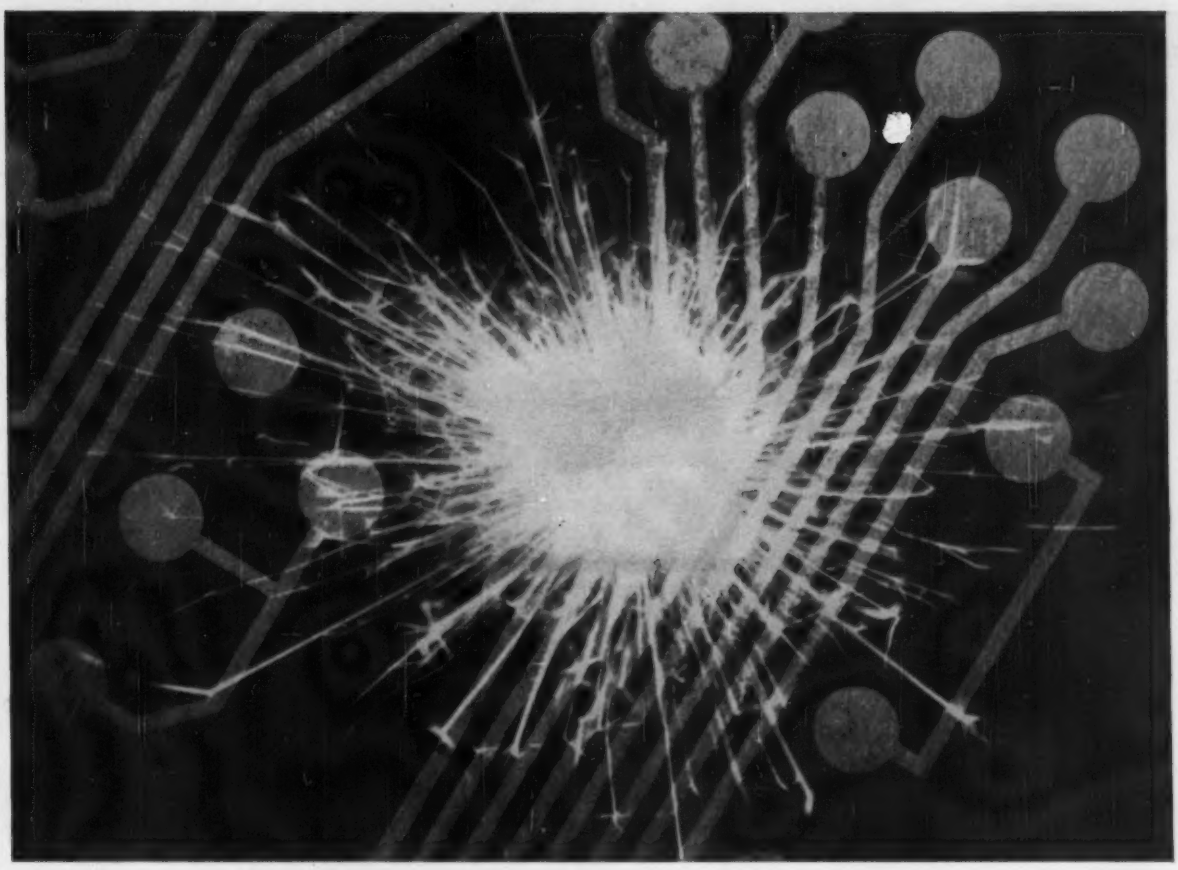


Uniformity of Taylor Rolled Copper-Clad Laminates helps prevent shorts in printed electronic circuits

Taylor Rolled Copper-Clad Laminates help prevent both shorts and open circuits: shorts because the copper is free of lead inclusions; open circuits because the metal is free of pits and pinholes. They have such high uniformity that even lines only 0.002 in. wide, and spaced only 0.004 in. apart, can be produced. These features also help prevent resistance buildup and other faults that cause failures in radios, television sets, and other electronic devices found in the home and industry.

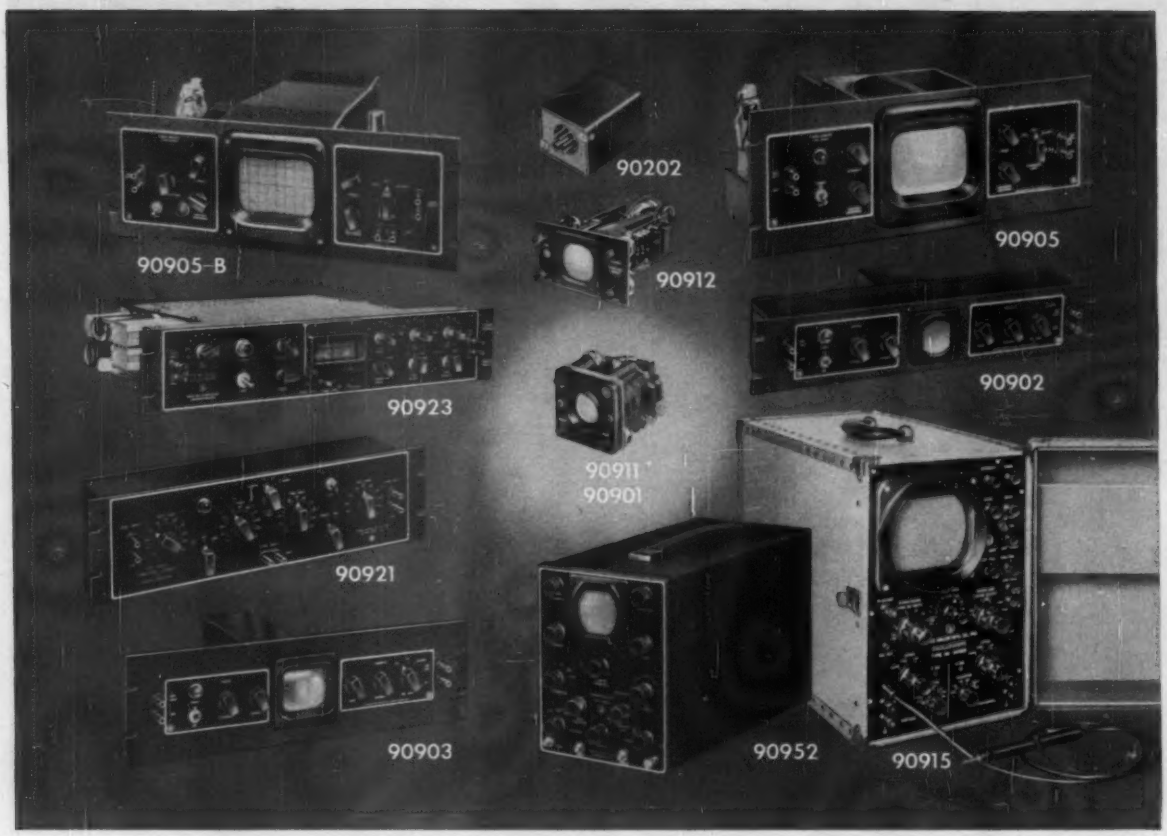
Production control at Taylor Fibre Co. is responsible for this highly uniform printed circuit material. Taylor has devised a unique method of bonding high-purity rolled copper to the base laminate—and keeping it securely bonded even under severe conditions of temperature, humidity and mechanical stresses. From this results the production of printed circuits of consistently high quality.

This is only one of the many Taylor Fibre Co. products that are meeting industry's demands for improved materials with superior performance characteristics. If your products require laminated plastics—in basic form or fabricated parts—contact Taylor Fibre Co., Norristown 40, Pa. Our plants at Norristown, Pa., and La Verne, Calif., are both fully equipped to give you engineering assistance as well as quick delivery on the laminated plastics you may need.

Actual size of printed circuit on Taylor Copper-Clad Laminate. The lines are only 0.002 in. wide and 0.004 in. apart.

Taylor

LAMINATED PLASTICS VULCANIZED FIBRE



"Designed for Application" • Oscilloscopes and Accessories

The extensive Millen "Designed for Application" line of oscilloscopes and accessories includes five instrumentation oscilloscopes, six rack mounted basic oscilloscopes, an insulated industrial oscilloscope, a miniature synchroscope-oscilloscope, two compact rack mounted complete oscilloscopes, a rack mounted basic oscilloscope for military applications, two amplifier-sweeps, and a plug-in power supply.

INSTRUMENTATION OSCILLOSCOPES

Miniaturized, packaged panel mounting cathode ray oscilloscopes designed for use in instrumentation in place of conventional "pointer type" moving coil meter. Magnitude, phase displacement, wave shape, etc. are readily displayed.

No. 90901 uses type 1CP1 fixed focus one inch cathode ray tube. 2½" x 2¾" panel. Panel bezel matches in size and type the standard 2" square meters.

No. 90911 uses Type 1EP1 cathode ray tube. Balanced deflection. Blanking input. Sharp focus. Panel matches 2" square meters. Flat face RCA 1¼" diameter tube.

No. 90912 uses type 2BP1 two inch cathode ray tube. 3" x 5" panel. Sharp focus. Good sensitivity. Accelerating voltage 500 to 875 volts. Min. control interaction.

No. 90912-R uses type 3UP1 2½" x 1⅝" rectangular cathode ray tube.

No. 90913 uses type 3XP1 3" x 1½" rectangular cathode ray tube. 1⅝" x 2¾" useful scan. Vertical sensitivity 33 volts d.c. per inch at 2000 v. accelerating.

BASIC OSCILLOSCOPES

Rack mounted inexpensive *basic* oscilloscopes including cathode ray tube circuit, power supply; intensity, focus, and centering controls, magnetic shielding, safety features, switches, etc. The *basic* oscilloscopes in their packaged form are entirely adequate for many laboratory as well as industrial and communication uses.

No. 90902 uses type 2BP1 two inch cathode ray tube. 3½" x 19" panel. Power supply — 105–125 volts — 60 cycles. Power consumption — 19 watts.

No. 90902-M — Military version of 90902.

No. 90903 uses type 3KP1 three inch cathode ray tube. 5¼" x 19" panel. Power supply — 105–125 volts — 60 cycles. Power consumption — 19 watts.

No. 90903-R uses type 3XP1 3" x 1½" rectangular cathode ray tube. 3½" x 19" panel. Power supply 105–125 volts — 60 cycles.

No. 90905 uses type 5UP1 five inch cathode ray tube. 7" x 19" panel. Power supply 105–125 volts — 60 cycles. Power consumption — 32 watts.

No. 90905-B uses type 5ADP1 five inch flat face precision tolerance cathode ray tube. Power supply — 105–125 volts — 60 cycles. Power consumption — 35 watts.

No. 90905-R uses type B1204 4⅝" x 2⅝" rectangular cathode ray tube. 3¼" x 19" panel.

INDUSTRIAL OSCILLOSCOPE

Suitable for use in factory, laboratory, and the field for design, installation, maintenance, and service. Completely insulated front panel and case. Double shielded against magnetic fields. Excellent linearity. Sharp focus over entire 4" x 4" useful scan. The vertical and horizontal amplifiers are stable d.c. amplifiers and are identical, thus permitting accurate phase measurements.

No. 90915 uses type 5AQP — 1, 2, 7, or 11 flat face, precision tolerance cathode ray tube. Frequency response of either amplifier D.C. to 100 K.C. + 0–10%.

MINIATURE SYNCHROSCOPE-OSCILLOSCOPE

Compact "field service" Synchroscope or Oscilloscope. 7¾" x 5⅝" x 13". Weighs 17 pounds. Synchronizes to internal or external positive or negative pulses. Band width 10 cycles to 1000 KC. Sweep 6 to 300 microseconds per inch. Performance has not been sacrificed in designing this unit for light weight.

RACK MOUNTED OSCILLOSCOPES

Complete with amplifiers and sweep. Good low frequency response and linearity. For monitoring, production test, or laboratory use. Compact.

No. 90923 uses type 3XP1 3" x 1½" rectangular cathode ray tube. 3½" x 19" panel.

No. 90925 uses type B1204 4⅝" x 2⅝" rectangular cathode ray tube. 3½" x 19" panel.

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Compact high voltage power supply for oscilloscopes, etc. 2" x 2½" x 5". Input 117 volts 50/60 cycles at 10 watts. Output 750 volts d.c. at 3 ma. and 6.3 volts a.c. at 600 ma. Supplies accelerating and centering potential for oscilloscopes.

No. 90202 Power Supply for Instrumentation Oscilloscopes.

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Horizontal and vertical amplifiers and sawtooth sweep generator for use with *basic* oscilloscopes. Match MILLEN *basic* oscilloscopes in appearance.

No. 90921 — 6SJ7 amplifiers. 6SN7-GT hard tube sweep. 5¼" x 19" rack panel.

No. 90922 — 3½" x 19" rack panel. Good low frequency linearity.

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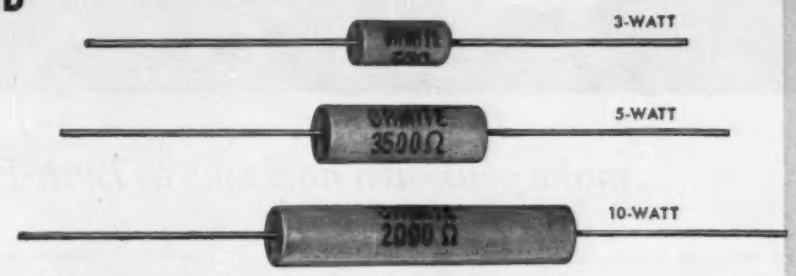
153

Ohmite Molded Precision Power Resistors are exceptionally high-quality units providing excellent performance. They are wound in a single layer on ceramic cores. Temperature coefficient of resistance is low, 0 ±20 ppm/°C. Tough, molded, silicone-ceramic covering—abrasion and moisture-resistant. Insulated units with high dielectric strength. Wide selection of resistance tolerances: 0.1%, 0.25%, 0.5%, 1.0%, and 3.0%. Uniform size—ideal for automated assembly. Designed to meet MIL-R-26C. Maximum resistance: 3-watt, 10,000 ohms; 5-watt, 25,000 ohms; 10-watt, 50,000 ohms.



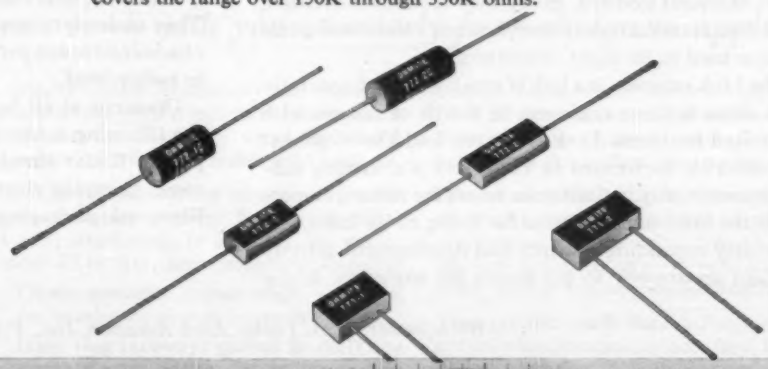
NEW

METAL-FILM

TYPE

BULLETIN
155

Ohmite RITEOHM® Metal Film Resistors feature full ¼-watt rating at 150°C ambient. These new units may be used at *full rated wattage* in higher ambients than other types of precision film resistors. Rated at ½ watt at 125°C. Excellent high-frequency characteristics; standard temperature coefficient is 0 ±25 ppm/°C over a wide temperature range of —55°C to +190°C. A T.C. of 0 ±50 ppm/°C is also available at lower cost; long term load and shelf stability. Resistance range: two sizes provide over-all range of 25 ohms to 350K ohms. The smaller unit provides resistances from 25 ohms through 150K ohms; larger unit covers the range over 150K through 350K ohms.



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TAP SWITCHES • TANTALUM CAPACITORS
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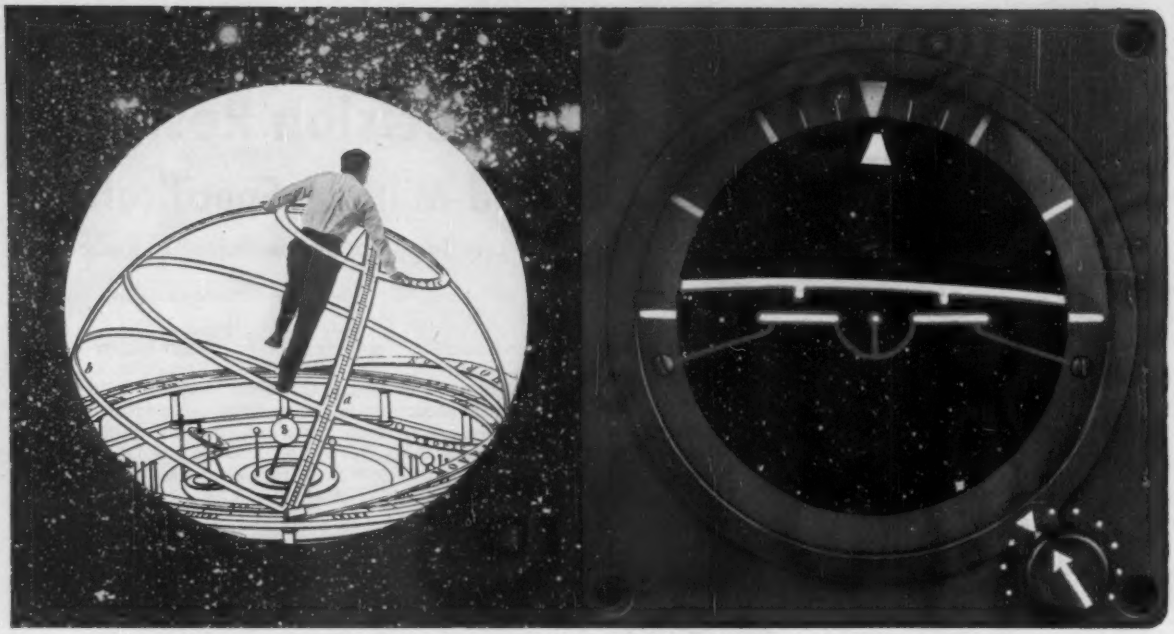
OHMITE MANUFACTURING COMPANY
3610 Howard Street, Skokie, Illinois

Be Right with OHMITE® QUALITY Components



make your own horizons at Link-Palo Alto

Man wants to *know*...everything. His insatiable curiosity drives him implacably upward, inspiring him to seek out new horizons. Even now he is shaking the earth-dust from his feet and making his way out into the universe. Man will yet find that there is no lost horizon.

At Link we make our own horizons, literally! No longer limited to flight simulation, the field we pioneered, Link has become an important systems designer in such fields as automatic control, optical and visual display systems, data processing, human engineering and automatic checkout systems. In the field of instrumentation, Link does manufacture its own horizon—the above gyro-horizon used in its flight simulators.

The Link complex is a hub of creativity, and naturally Link attracts those engineers in search of careers with unlimited horizons. Link Research and Development Laboratories are located in Palo Alto, a charming suburban community in California where the natural climate rivals the intellectual climate for living at its finest.

Greatly expanding research and development activity has lent an urgency to the search for engineers. Many special advantages accrue to Link employees including the Stanford University Honors Cooperative Program which provides advanced study, under regular university curriculum, with all tuition expenses provided by Link.

In addition to furnishing you with an ideal atmosphere in which to work and an enviable academic program to advance your studies, Link supplies all employee benefits associated with the most advanced management practices, such as fine pay and generous hospital, health and retirement benefits.

And most important: management men are engineers. They understand your work and point of view. This kind of administration provides engineering thinking right up to policy level.

Openings at all levels exist for engineers qualified in the following fields: Digital computers, Analogue computers, Radar simulators, Automatic check-out equipment, Complex electronic simulators, Optical systems, Electronic packaging.

Reach for your new horizon now!

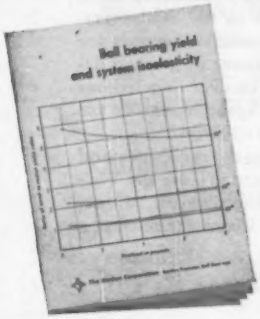
Write to Mr. E. A. Larko, Link Aviation, Inc., P.O. Box 1318 Palo Alto, California.

LINK — GPE GENERAL PRECISION EQUIPMENT CORPORATION

LINK AVIATION, INC.
A subsidiary of General Precision Equipment Corporation
Openings also exist at our plant in Binghamton, New York. Information forwarded on request.

Barden Precision Z148 bearings specially designed for a gyro rotor

BARDEN *engineers work with you creatively from design to application*



Write for the Barden booklet, "Ball Bearing Yield and System Isoelasticity." An aid to application of precision instrument bearings, it offers background data on axial and radial play, axial take-up, preloading, isoelastic bearings and achievement of system isoelasticity.

To achieve system isoelasticity and minimize moment errors, gyro rotors need bearings that provide rotational accuracy, exact positioning and controlled axial and radial yield rates.

All standard *Barden Precision* bearings have the extreme accuracy required for precise radial and axial positioning. In addition, the special purpose Z148 has these important features:

Closely controlled contact angles—essential for bearing or system isoelasticity

Inner ring raceways ground in shaft—to simplify rotor design . . . reduce mating part errors . . . improve bearing alignment

One of hundreds of Barden "specials," the Z148 is an example of the results that stem from working creatively with Barden engineers from the earliest design stage.

Like all *Barden Precision* bearings, standard or special purpose, the Z148 is planned for *performance* from research and design, through quality controlled production, functional testing and application engineering.

Your product needs *Barden Precision* if it has critical requirements for accuracy, low torque or low vibration . . . if it operates at extreme temperatures or high speed.

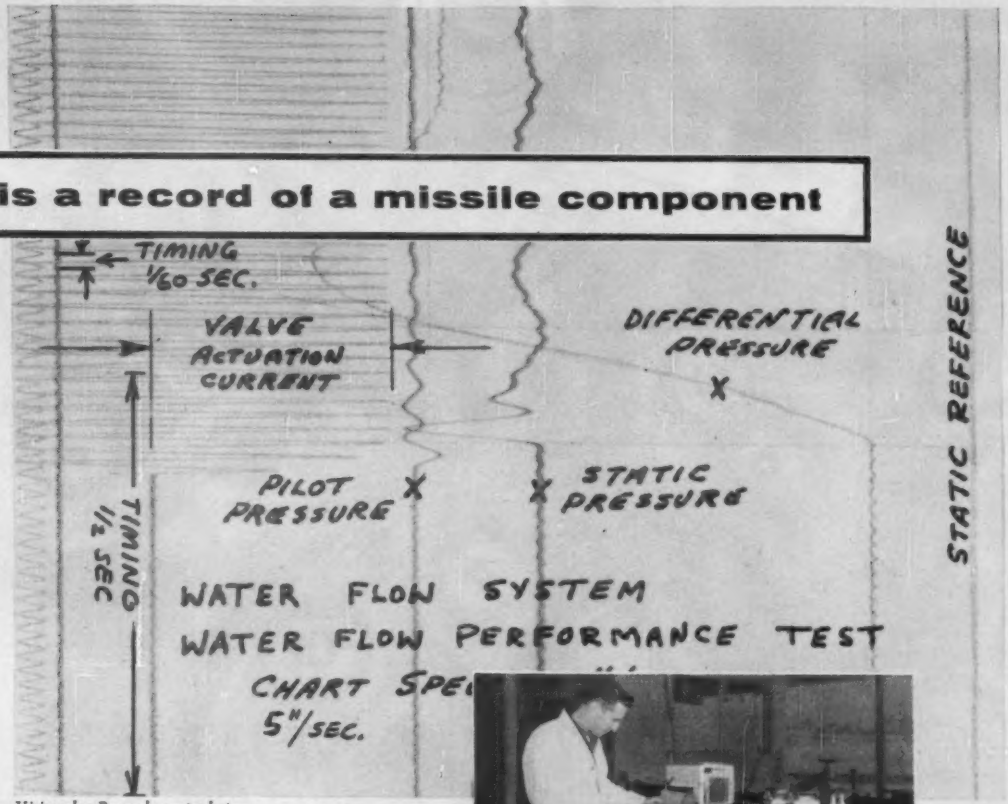
THE BARDEN CORPORATION

45 E. Franklin St., Danbury, Connecticut • Western office: 3850 Wilshire Blvd., Los Angeles 5, California

SPECIFY BARDEN PRECISION BALL BEARINGS FOR: INSTRUMENTS • COMPUTERS AND RECORDERS • AIRCRAFT ACCESSORIES • MACHINE TOOL AND TEXTILE SPINDLES • OTHER PRECISION APPLICATIONS

CIRCLE 49 READERS SERVICE CARD

This is a record of a missile component



Visicorder Record—actual size

Wyle Laboratories in El Segundo, California, have used a battery of four Visicorder consoles like the one shown *(right)* to run a series of tests on a vital missile component. In the Wyle test project, the unique Visicorder consoles are easy to operate. Most parameters are low frequency, requiring response on the order of 5 to 60 cycles.

The two calibrator control panels in each Visicorder console accommodate 10 plug-in balance and matching units—designed to match tachometer generators, pressure transducers, thermocouples, expanded-scale voltmeters, etc., to the Heiland galvanometers.

Dick Johnson, Instrumentation Branch Head at Wyle, says, "This system, I feel, is one of the most efficient instrumentation consoles in operation. Set-up and calibration time has been reduced by the use of Visicorders by approximately 50%. This is due to the simplicity of operation and trouble-free performance. There are no inking pens to clean, high-gain amplifier maintenance, and so on, and we can also use these consoles together to form systems of more than six channels."

Tom Jackson, Wyle engineer, examines Visicorder record

The HONEYWELL VISICORDER is the first high-frequency, high-sensitivity direct recording oscillograph. In laboratories and in the field everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

To record high frequency variables—and monitor them as they are recorded—use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Honeywell

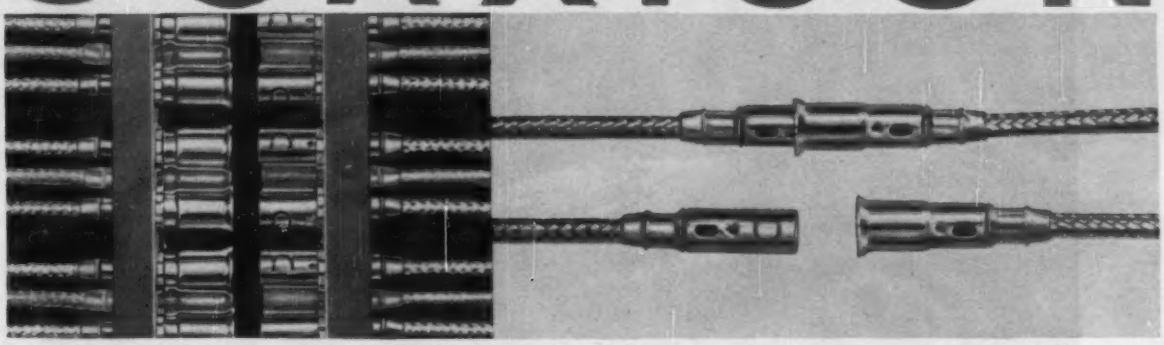
H Industrial Products Group

Reference Data: Write for Visicorder Bulletin.

Minneapolis-Honeywell Regulator Co., Industrial Products Group, Heiland Division, 5200 E. Evans Ave., Denver 22, Colorado

THE NEW CONCEPT IN COAXIAL DISCONNECT SPLICING...

COAXICON



Here is a totally new method for attaching disconnect splices to coaxial cables that will create new standards of performance . . . on chassis connections, computers, test equipment—in fact, anywhere that two coaxial cables need fast and reliable disconnect splicing.

Easily attached to coaxial cables by AMP's modern compression method, the all new A-MP COAXICON assures you of uniformity, absolute reliability and new low cost—in either free-hanging or through-panel units. In addition, the COAXICON supports cable shielding against vibration while offering fully insulated positive electrical performance.

Production rates easily exceed any method you're now using. With a simplified wire stripping method, it takes just one stroke of the matching A-MP tool to permanently crimp COAXICON to your coaxial cable.

Think of it—no more burned or melted insulation, no doubtful, sloppy connections, no time consuming, high-cost assembly methods. Once you've seen the all new COAXICON, you won't settle for less.

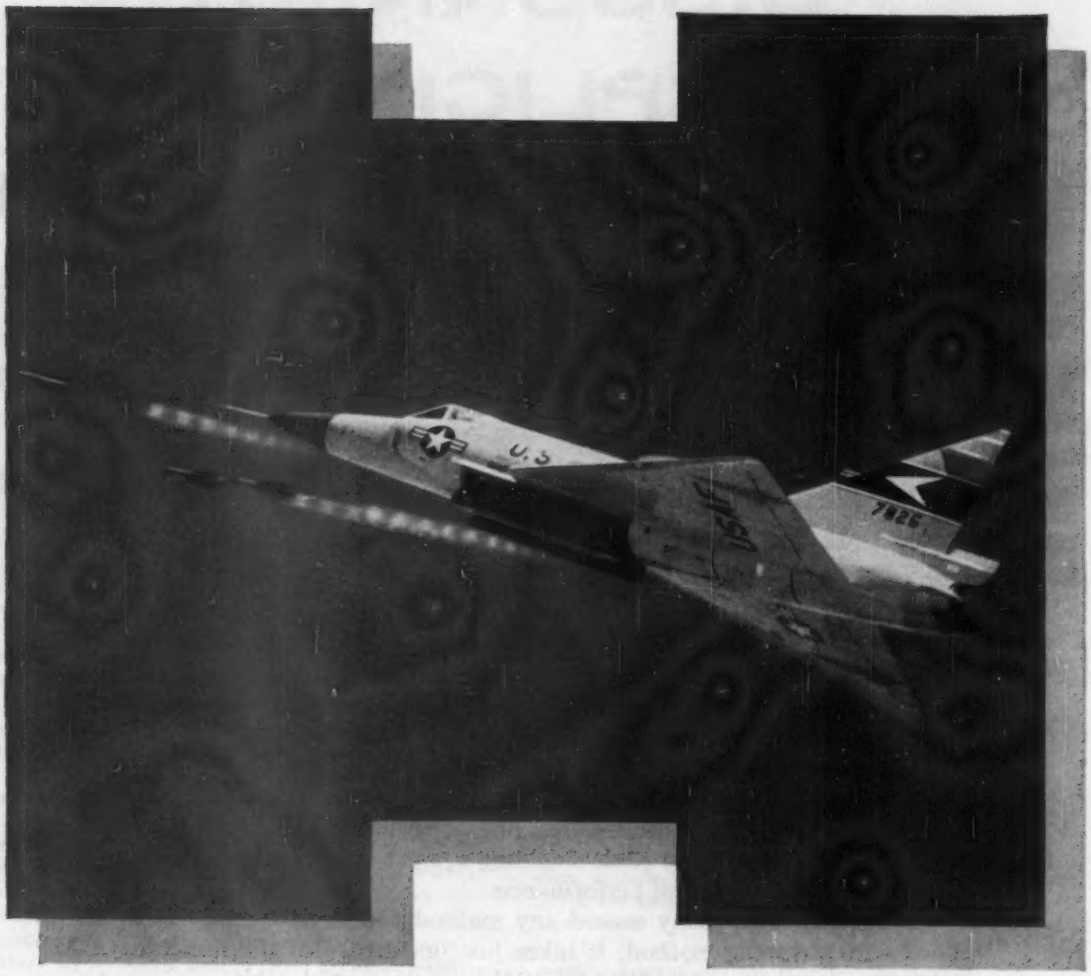
Send for a sample and complete product information today.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan

Sharpening



the Falcon's claw

Faster flying, higher climbing, farther reaching ...the new supersonic Falcon air-to-air guided missile. Conceived, developed, and manufactured by Hughes Engineers, it is today's best performing air-to-air missile.

The Super Falcon GAR-3, newest in the family of Falcon missiles, is powered by a new and longer-lived solid propellant rocket engine. It can climb far beyond the altitude capabilities of the interceptor and destroy an enemy H-bomber in any kind of weather.

Hughes Research & Development Engineers, always moving forward, are also developing the GAR-9, a new atomic air-to-air missile which will be used with the F-108, a fantastically swift long range interceptor being built for the Air Defense Command.

The new atomic missile will be able to reach out over extremely long distances and destroy enemy bombers long before they reach their U.S. and Canadian targets.

Advanced Research & Development at Hughes is not confined to just guided missiles. Investigations presently underway at the Hughes R&D Laboratories include Space Vehicles, Advanced Airborne Systems, Nuclear Electronics, and Subsurface Electronics... just to name a few. At Hughes in Fullerton engineers are engaged in the Research, Development and Manufacture of advanced three-dimensional radar systems. At Hughes Products, the commercial activity of Hughes, advanced Research & Development is being performed on automatic control systems, microwave tubes, and new semiconductor devices.

The challenging nature and diversity of Hughes projects makes Hughes an ideal firm for the Engineer or Physicist interested in advancing his professional status.

Photo at left shows Convair F-102 firing salvo of Falcon GAR-1 air-to-air guided missiles.

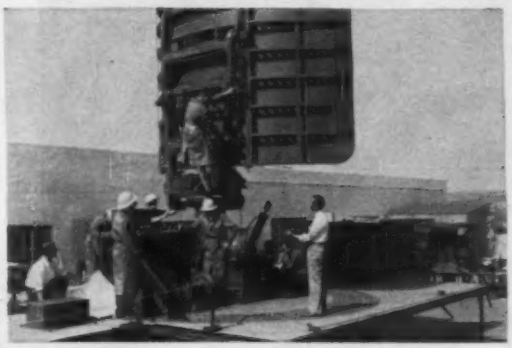
An immediate need now exists for engineers in the following areas:

Computer Engineering	Systems Analysis
Field Engineering	Microwaves
Semiconductors	Circuit Design
Technical Training	Communications
Microwave Tubes	Radar

Write in confidence, to Mr. Phil N. Scheid, Hughes General Offices, Bldg.6-W-1, Culver City, California.

© 1958, HUGHES AIRCRAFT COMPANY

Sophisticated Hughes Electronic Armament Systems control high-speed jet interceptors from take-off to touch down, and during all stages of the attack.



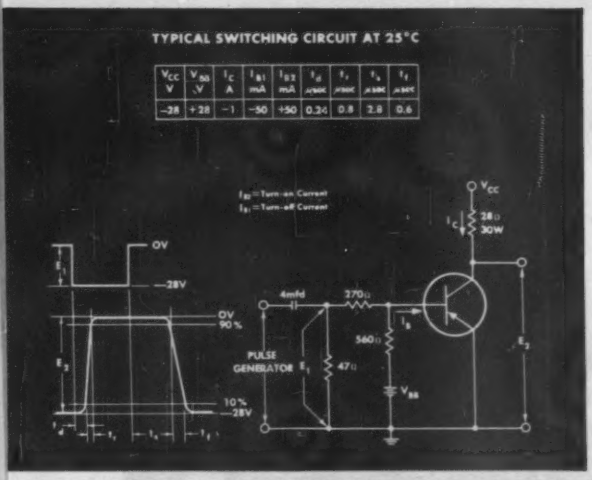
Ground Systems being developed at Hughes in Fullerton provide mobile three-dimensional radar protection and high-speed data handling.

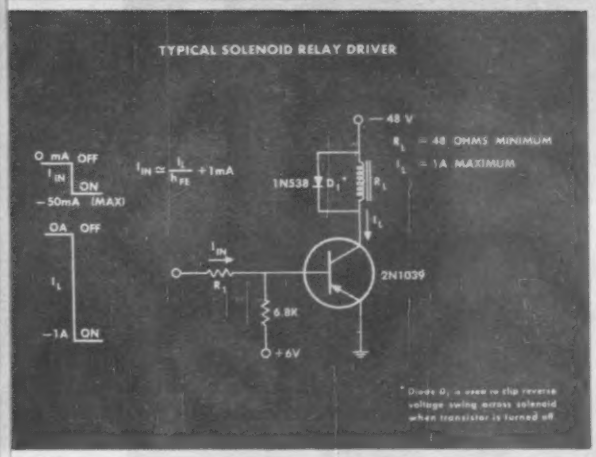
Creating a new world with ELECTRONICS

HUGHES

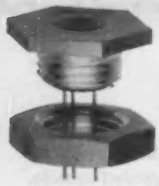
HUGHES AIRCRAFT COMPANY
Culver City, El Segundo,
Fullerton and Los Angeles, California
Tucson, Arizona

INDUSTRY'S BROADEST LINE OF





NEW POWER SWITCHING TRANSISTORS


(ACTUAL SIZE)

NEW P-N-P germanium power switching transistors *guarantee* 5.5 W dissipation at 25°C with voltage ratings of 40, 60, 80, and 100 volts for optimum design flexibility. The functional design of the heat sink assures rapid installation requiring only one mounting hole through the chassis.

You get *guaranteed* 20-to-60 beta spread and a low 0.16 ohm saturation resistance at the 3A maximum collector rating. In addition, a maximum 125 μA collector reverse current is *guaranteed* at one-half rated breakdown voltage with TI 2N1042, 2N1043, 2N1044, and 2N1045 alloy junction transistors.

These new devices are well suited for your switching circuits . . . relay drivers . . . audio and pulse amplifiers.

NEW MEDIUM POWER SWITCHING TRANSISTORS

(ACTUAL SIZE)

NEW P-N-P germanium medium power transistors give you switching times as low as 1.1 μsec. TI 2N1038, 2N1039, 2N1040, and 2N1041 alloy junction transistors provide 800 mW dissipation in free air at 25°C, 450 mW at 55°C . . . with voltage ratings of 40, 60, 80, and 100 volts.

In addition, *guaranteed* 20-to-60 beta spread and low 0.2 ohm saturation resistance assure reliable performance for your high speed switching circuits . . . relay drivers . . . low power audio and pulse amplifiers.

		Type	Dissipation at 25°C	Collector Voltage-V max	Collector Current A max	Beta min	Beta max	Collector Reverse Current I_{CO} max μA	Collector Reverse Current I_{CO} max V	Saturation Resistance Ohm
computer power	pnp	2N1046	15W	−80	−3	40	70 (Avg)	−1mA	−40	0.75
medium power		2N1038	800mW	−40	−1	20	60	−125	−20	0.2
	pnp	2N1039	800mW	−60	−1	20	60	−125	−30	0.2
		2N1040	800mW	−80	−1	20	60	−125	−40	0.2
		2N1041	800mW	−100	−1	20	60	−125	−50	0.2
power		2N456	50W	−40	−5	30@5A avg.		−2mA	−40	0.048
	pnp	2N457	50W	−60	−5	30@5A avg.		−2mA	−60	0.048
		2N458	50W	−80	−5	30@5A avg.		−2mA	−80	0.048
		2N1021	50W	−100	−5	23@5A avg.		−2mA	−100	0.08
		2N1022	50W	−120	−5	23@5A avg.		−2mA	−120	0.08
		2N1042	5.5W	−40	−3	20	60	−125	−20	0.16
		2N1043	5.5W	−60	−3	20	60	−125	−30	0.16
		2N1044	5.5W	−80	−3	20	60	−125	−40	0.16
		2N1045	5.5W	−100	−3	20	60	−125	−50	0.16

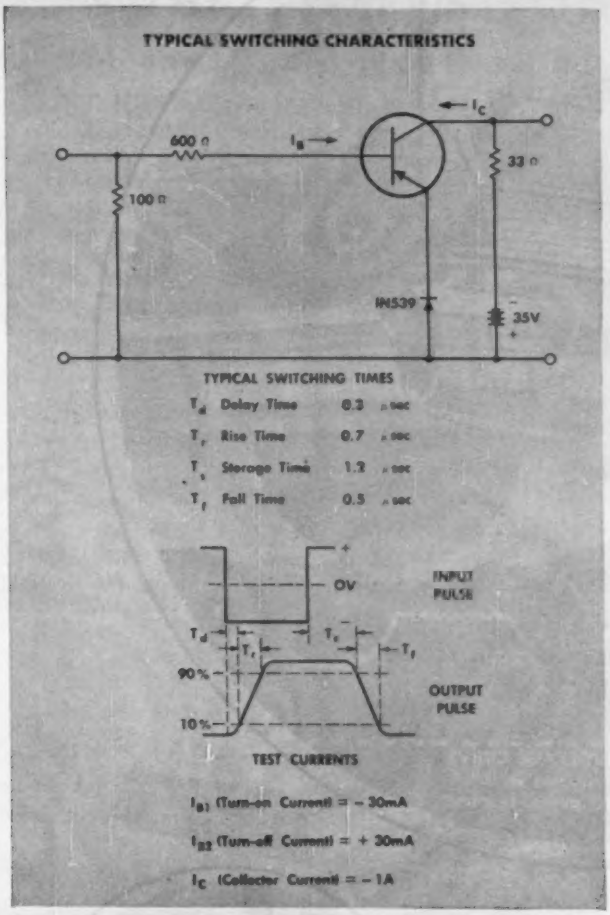
IMMEDIATELY AVAILABLE IN PRODUCTION QUANTITIES OR . . .

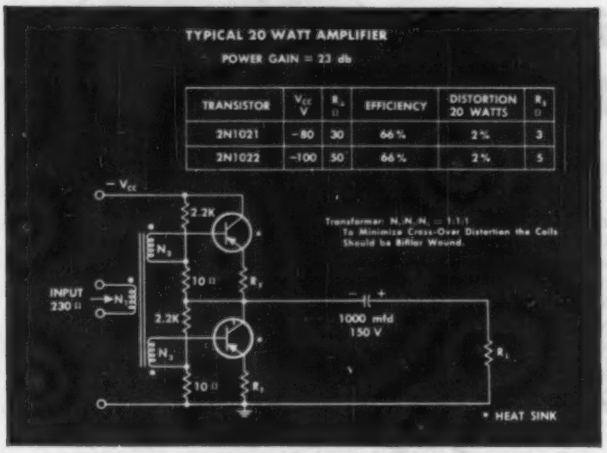
TEXAS

WORLD'S LARGEST SEMICONDUCTOR PLANT

CIRCLE 54 READERS SERVICE CARD

GERMANIUM POWER TRANSISTORS!




TYPICAL 20 WATT AMPLIFIER
POWER GAIN = 23 db
TRANSISTOR | V_{CC} V | R_L Ω | EFFICIENCY | DISTORTION 20 WATTS | R_1 Ω
2N1021 | −80 | 30 | 66% | 2% | 3
2N1022 | −100 | 50 | 66% | 2% | 5
2.2K
10 Ω
INPUT 230 Ω
1000 mfd 150 V
* HEAT SINK

NEW HIGHEST FREQUENC COMPUTER POWER TRANSISTO

(ACTUAL SIZE)

NEW TI 2N1046 combines *high power, high f quency* and *high voltage* performance in a sing transistor package! This P-N-P diffused base germ nium transistor has *guaranteed* dissipation to watts and collector breakdown voltage to 80 vo with 12 mc typical alpha cutoff. Extremely low c lector reverse current averaging 0.2 ma at 40 vo and a low 0.75 ohm saturation resistance assure re able operating characteristics.

Designed for your deflection circuits and comput core driving applications, the 2N1046 has a typi 10mc internal cutoff frequency, f_T (point at whi forward current transfer ratio equals unity).

NEW HIGHEST VOLTAG TRANSISTORS

(ACTUAL SIZE)

NEW TI 2N1021 and 2N1022 germanium transisto *with maximum operating voltages of 100 V and 120 respectively,* provide typical betas of 70 at 1A. 23 at 5A!

You get *guaranteed* 700 μA maximum collector r verse current at one-half rated voltage and 2m maximum at full rated voltage in addition to e tremely low saturation resistance . . . 0.08 ohm R

For your audio, servo and power applications, co sider these outstanding performance characteristi and specify TI germanium transistors.

OFF THE SHELF IN 1-99 QUANTITIES FROM YOUR NEARBY TI DISTRIBUTOR

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CIRCLE 55 READERS SERVICE CARD

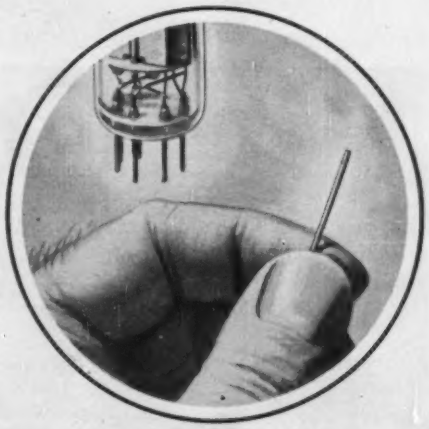
For mobile electronic equipment—

New Cathodes Lick The Overvoltage Threat

High heater voltages ordinarily doom electron tubes to a short life. But Superior's new cathode alloy, Cathaloy® A-31, gives them a resistance to overvoltage damage unmatched by any other alloy.

This has been proved in car radios and other mobile electronic equipment. Voltages commonly range upwards of 25% over specification. And tubes with these new Superior cathodes consistently outlast others—by hundreds of hours.

This significant advance in electron tube performance is one of the practical benefits that keep coming your way from the laboratories of Superior Tube . . . world's leading independent supplier of cathodes for electron tubes. For information on Superior cathodes, write for Catalog Section 51, Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.



Survives high heater voltage. New Superior Tube cathode prolongs electron tube life in mobile electronic equipment.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

Johnson & Hoffman Mfg. Corp., Mineola, N.Y.—an affiliated company making precision metal stampings and deep-drawn parts, such as those used in the electron guns that go with this new cathode.

ONLY ONE POTENTIOMETER THIS SMALL GIVES YOU THESE 5 FEATURES

Mount 16 units per square inch—cross-section only 0.190″ x 5/16″

1. High temperature operation—to 175°C.
2. Humidity-proof—new plastic molding technique makes possible a smaller, fully-sealed potentiometer exceeding specifications of MIL-STD-202A, 10 days.
3. Power rating: one watt at 70°C.
4. Standard mounting holes on one-inch centers.
5. Easier, more accurate settings—25 turn screw driver adjustment gives you 33 times the adjustability of single-turn potentiometers, easy repeatability. Settings are stable and self-locking.

SEE US AT THE WESCON SHOW, BOOTH 1104

IT'S THE NEW BOURNS TRIMPOT® MODEL 224

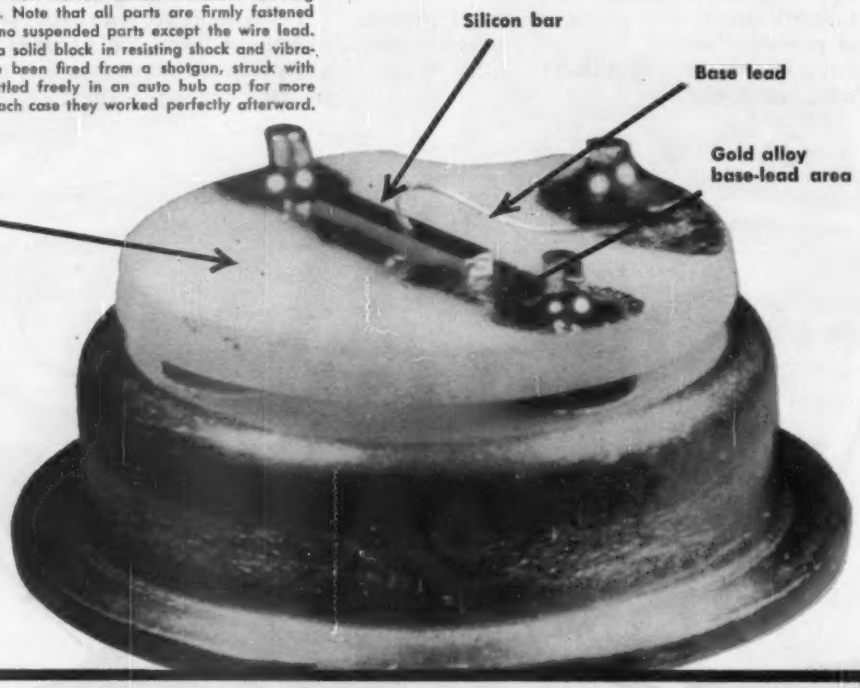
Available immediately from factory or distributors' stock with insulated stranded leads, solder lugs or printed circuit pins. Resistances: 100Ω to 50K. Exceeds military shock and vibration specs. For data on the new Model 224 TRIMPOT write to:

BOURNS *Laboratories, Inc.* P.O. Box 2112F, Riverside, California

EXCLUSIVE MANUFACTURER OF TRIMPOT® AND TRIMIT® • PIONEERS IN POTENTIOMETER TRANSDUCERS FOR POSITION, PRESSURE AND ACCELERATION

New 45-volt silicon transistor absorbs

Photomicrograph of new 45-volt silicon transistor showing Fixed Bed Mounting. Note that all parts are firmly fastened to each other, with no suspended parts except the wire lead. Transistor reacts as a solid block in resisting shock and vibration. Test units have been fired from a shotgun, struck with a golf club, and rattled freely in an auto hub cap for more than 700 miles. In each case they worked perfectly afterward.



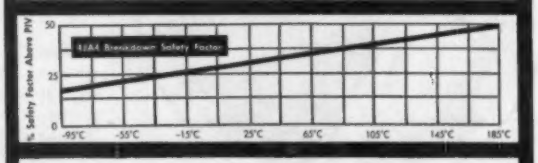
20% safety factor announced for low-current silicon rectifiers

Designers who now apply their own safety factor to the published peak inverse voltage rating may avoid this step by using G-E low-current silicon rectifiers.

General Electric's PIV figures are set by allowing a 20% safety margin at −65°C. This margin is applied at the point of sharp breakdown voltage and increases with temperature until a maximum safety factor of 33% is reached at 150°C.

If you are derating published PIV figures to provide over-voltage protection, you may be buying costlier cells than you need, or, in series applications, more cells than necessary. Thus the built-in safety margin of G-E low-current silicon rectifiers could save you money. *Note: This safety factor is provided for over-voltage protection only. Designs should, in all cases, be maintained within published maximum ratings.*

This is only one reason why you should consider G-E low-current silicon rectifiers for *all* your power requirements. You'll find these devices more attractive to use than ever before—both in quality and price—with equally fine values in low-current silicon stacks. Stud-mounted units are also available. Ask your G-E semiconductor representative for the "big news" on low-current silicon rectifiers.



Maximum Ratings and Specifications

	PIV	RMS Voltage	Cont Reverse D-C Volt	D-C Output (150°C Amb.)	D-C Output (50°C Amb.)	Ambient Operating Temp.
1N536-40, 1N1095-98 series	50-600	35-420	50-600	250	750	165
1N648EB series	100-600	70-420	100-600	300-500 (100°C)	900-750	150-165
1N1487-92 series	100-600	70-420	100-600	250 (125°C)	750 (25°C)	140
1N1692-95 series	100-400	70-280	100-400	250 (100°C)	600 (50°C)	115
	volts	volts	volts	ma	ma	°C

abuse far beyond present specs— and keeps on working!

Fixed Bed Mounting and super-clean processing result in superior electrical reliability and stability

Nominal Electrical Characteristics at 25°C
(2N332-336 rated at V_{CB} = -5V, I_E = 1ma, f = 1kc)
2N337-338 rated at V_{CB} = -20V, I_E = 1ma, f = 1kc)

	2N332	2N333	2N334	2N335	2N336	2N337	2N338
Current Transfer Ratio	15	20	30	60	120	55	99
Alpha Cutoff Frequency (V_{CB}=-5V; I_{EO}=-1ma)	10	12	13	14	15	20	45mc
Collector Capacity (f=1 mc)	7	7	7	7	7	1.4	1.4 μμf
Collector Breakdown Voltage (I_{CBO}=-50 μa, I_E=0)	45 min.	45 min.	45 min.	45 min.	45 min.	45 min.	45 min. volts
Collector Saturation Resistance (I_B=-2.2ma, I_C=-5ma)	90 200 max.	80 200 max.	75 200 max.	70 200 max.	70 200 max.	75* 150 max.	75** 150 max.
Collector Current (V_{CB}=-30V, I_E=0) (V_{CB}=-5V, I_E=0, T_A=150°C)	.002 30 max.	.002 30 max.	.002 30 max.	.002 30 max.	.003 50 max.	.002***	.002 μa max.***
Common Emitter Current Gain (Min DC beta at 10ma)						30	45

*I_B -1ma, I_C -10ma **I_B -5ma, I_C -10ma ***V_{CB} -20V I_E 0

This new series of high-voltage silicon transistors promises designers more reliable physical and electrical performance than ever before in amplifying and switching circuits. Fixed Bed Mounted transistors have been tested in some cases to more than twice present requirements—72 inch drop test instead of 30 inches, 1300 G shock test instead of 500—without evidence of failure.

Fixed Bed Mounting also results in improved uniformity of electrical parameters (controlled, low saturation resistance is an example). Improved processing does the rest. No fluxes, solders or resins are used, only a high-temperature-melting gold alloy which forms an integral bond between all parts. This, plus a new surface treatment, yields a series of transistors with highly stable I_{co} and beta under conditions of storage and operating life at maximum ratings.

Manufacturers who have tested the first sample units report "extremely consistent parameters." Mechanically, Fixed Bed Mounting obsoletes all present standards of performance for silicon transistors. Test these remarkably reliable transistors yourself. Ask your G-E semiconductor representative for complete details.

More G-E transistors meet Air Force specifications

Types USAF 2N43A
USAF 2N44A

Absolute Maximum Ratings (25°C)

Voltages		
Collector to Base	V_{CB}	—45 volts
Collector to Emitter	V_{CE}	—30 volts
Emitter to Base	V_{EB}	—5 volts
Collector Current	I_C	—300 ma
Temperatures		
Storage	T_{STG}	Max. + 100°C Min. —65°C
Operating Junction	T_J	Max. + 85°C

D-C Electrical Characteristics (25°C)
(Design Center)

		USAF 2N43A	USAF 2N44A
Forward Current Gain, Common Emitter I_C/I_B (V_{CE}= —1V; I_C= —100ma)	h_{FE}	48	25

These are General Electric's familiar germanium audio PNP transistors which have been widely used in civilian applications for the past several years. If you are designing transistorized equipment for the military, remember that G.E.'s '43A and '44A meet military specifications.

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2N501—high gain, super high frequency germanium micro alloy switching transistor for use in extra high frequency counters, logic circuits and wide-band video amplifiers.

2N502—very high frequency small signal amplifier micro alloy transistor for general purpose amplification at frequencies up to 400 m.c.

2N535—micro-miniature high gain, general purpose audio frequency germanium PNP junction transistor for use in metering decoders, signal amplifiers and telemetering applications where outstanding reliability is required in minimum space.

2N598—medium frequency, medium power, high current PNP alloy junction transistor for counters and logic circuits.

2N600—studded version of 2N598 for applications requiring higher power dissipation.

2N670—very high peak current, high voltage, low frequency PNP germanium alloy junction transistor in JETEC-type package. The 2N670 is specifically engineered for pulse modulators and pulse line drivers.

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electronics
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NOVEMBER 7, 1958

Systems engineer checks out automatic-pilot computer and amplifier as part of overall system test

Designing Safety Into Automatic Pilot Systems

Systems can be monitored by protection circuits that give alarm or shut equipment off when either control or safety circuit breaks down. Typical torque limiting and modulating circuits for control surfaces are cited

By C. W. McWILLIAMS, Chief Engineer, Autopilot Systems
Eclipse-Pioneer Div. of Bendix Aviation Corp., Teterboro, N. J.

SAFETY REQUIREMENTS for aircraft surface-actuator systems require that they never produce hazardous loads on the aircraft or create dangerous deviations in the flight path either during normal operation or in case of malfunction.

One of the most direct ways of achieving protection in main control-surface actuating systems is by limiting the torque that can be applied to the control surface or its control tab. As the margin between the torque required to properly fly the aircraft and the maximum torque permitted is small, accurate and reliable control of torque is necessary.

In aircraft whose automatic pilot provides automatic pitch trim for steady-state flight, an important safety requirement is that the automatic trim system operate the trimming surface. This is an auxiliary control surface on the elevator whose function is to trim the elevator for a steady-state flight, an important must be operated continuously during autopilot operation to relieve the main pitch-surface actuator (elevator servo) of holding a fixed surface deflection against a load. The trim servo is normally set into operation when the voltage applied to the elevator servo indicates a sizable torque is being applied to the elevator. The trim surface deflection should be in a direction to minimize the elevator torque required to hold the aircraft in the trim condition.

The surface-actuator safety systems to be described use circuits that are typical of those required in modern flight control systems.

Pitch Axis System

A simple, but typical, servo system for the pitch axis of an aircraft

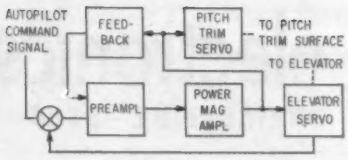


FIG. 1—Pitch-axis servo channel

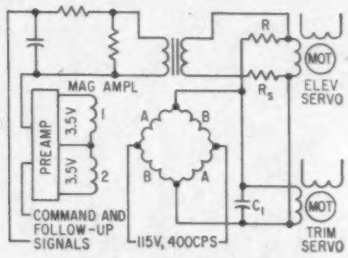


FIG. 2—Detailed circuit of block representation of Fig. 1

is shown in Figs. 1 and 2.

Automatic pilot command signals are fed through a transistor preamplifier (Fig. 3) to a power magnetic amplifier that drives the elevator servo motor. The motor operates the elevator surface through the gear train and engage clutch. Rate generator and follow-up signals are fed back into the input circuit in opposition to command signals. Degenerative feedback improves amplifier operation and stabilizes gain. The trim servo receives power commands from the power magnetic amplifier in parallel with the elevator servo motor.

Power Amplifier

The power magnetic amplifier is of the bridge type whose output voltage and phase are controlled by d-c signals in its control coils. As shown in Fig. 2, 115-v 400-cps power is applied across two points of the bridge and output power is fed to motors from the other two points. Capacitor C_1 provides impedance matching and phasing of the variable-phase voltage with respect to fixed phase.

When high current is present in control coil 1 and low current is present in 2, the bridge arms *A* are saturated, forming low impedance paths for the a-c power. This results in most of the excitation voltage being applied across the motor. When control currents are reversed, a similar voltage of opposite phase is applied to the motor producing opposite output torque. In the same way, power is applied concurrently to the trim servo motor, which is electrically in parallel with the elevator motor.

The magnetic amplifier and the two variable-phase motor fields are designed for parallel connection of the trim and elevator servos. Such operation results in a trim system possessing a high degree of safety since practically all of the trim system circuitry is common with the elevator system.

Electrical faults occurring before the parallel connection points that result in loss of signal cause both servos to be inoperative, which is a fail-safe condition. Any faults that result in a bias or apparent command signal will be evident to the pilot through abrupt elevator response, which is quite rapid compared with slow moving trim system.

Short circuits or opens at the trim motor or in cabling to it will result in nonoperation of the motor. No single failure can cause the trim servo to run away or operate independently of the elevator channel so as to build up a large counteracting sustained elevator deflection. Hence, the danger of large transient maneuvers occurring at autopilot disengagement is greatly minimized.

Torque Limiter

The element which limits the power applied to the servo motors, hence the torque, is the bridge magnetic amplifier. This amplifier is designed to supply the highest voltage and largest amount of power required for the application.

Independent of the command-signal strength, output voltage is sharply limited to what the magnetic amplifier is inherently capable of supplying, or approximately 90 percent of excitation voltage. No single fault can cause any appreciable increase in voltage applied to motors. For this reason the power magnetic amplifier can be relied upon as a safe type of voltage limiter.

Further protection is afforded by the servo variable-phase voltage being high compared with other voltages present in aircraft wiring. As a result, there is no chance of a higher voltage being applied to the servo motor because of a short circuit in the cabling.

The elevator servo is critical regarding maximum torque; this is usually not true of the trim servo. The maximum voltage applied to the elevator servo can be controlled by *R* in Fig. 2. Since the bridge magnetic amplifier is a fixed limit, variation in *R* results in variation of torque limit.

The overall feedback network starts at the elevator servo motor leads and provides about 20 db of negative feedback. This amount permits sizable changes in the value of *R* without any appreciable change in overall gain. Therefore, maximum permissible torque can be varied without appreciably changing gain or torque gradient in the linear amplifier region that is important to autopilot performance.

Torque Modulation

The torque limit may be a fixed value on each axis of a specific aircraft or it may be changed during flights. When wide variations are required a method of torque variation or modulation is available that

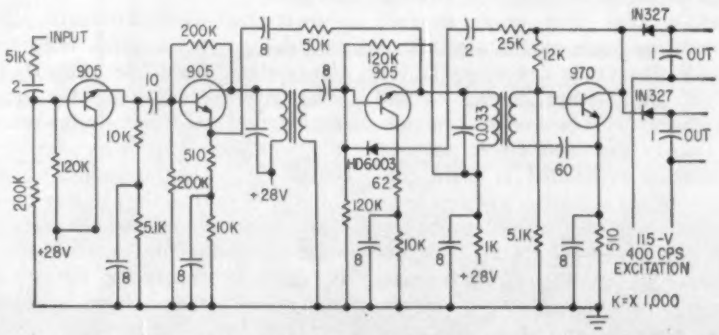


FIG. 3—Preamplifier for pitch-axis channel employs four npn silicon transistors

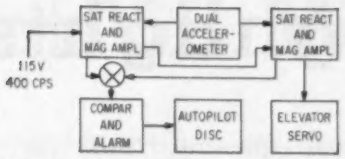


FIG. 4—Torque-modulation system has dual accelerometer that measures acceleration in pitch plane of motion. Servomotor torque is proportionately decreased with increasing acceleration

is actually a self-adjusting system wherein normal and angular accelerations in the pitch axis are measured and cause a proportional reduction in torque as normal g loading on the aircraft increases. In this manner the elevator servo always exerts the torques necessary for good performance under different flight conditions, but within safe limits. Since such a system is protecting the aircraft from structural damage or a dangerous maneuver, it in itself must be fail safe.

A block diagram illustrating this type of system is shown in Fig. 4.

The sensing element is a dual accelerometer located in the aircraft to measure acceleration in the pitch plane of motion. Both accelerometers are identical and feed signals to separate and identical magnetic amplifiers which control saturable-reactor coils. Both coils are in series with the a-c power source and the fixed phase of the elevator servo motor.

As acceleration signals increase from zero, independent of sign, the impedance of the reactors is increased to proportionally reduce motor torque. Each accelerometer, amplifier and saturable reactor channel contributes to half the voltage drop needed for the torque reduction required for a given acceleration.

Use of dual channels instead of one provides a high degree of safety since a comparison type of monitoring system can be used.

Comparator Circuit

As shown in Fig. 4, a comparator-alarm circuit measures and compares each of the voltage drops across the two reactors. When both channels are operating properly, the voltage across each reactor coil will be equal within tolerance limits and the comparator will not activate an alarm or disengage the automatic pilot. In the event of an appreciable difference, however, an alarm will be activated and the automatic pilot disengaged. The circuit, which includes both semiconductors and magnetic amplifier elements, is shown in Fig. 5.

Mixing

The two input voltages are applied to the input winding of the mixing transformer whose output, a voltage representing the arithmetic difference of the two inputs, is applied to the base of Q_1 through the R-C and diode network. The positive emitter voltage back biases Q_1 to permit normal I_{co} current flow in the collector circuit through control coils A and B when R is properly adjusted and no input signal is present.

When the a-c input level just rises to a point where the transistor is cut off, the base-collector junction is biased in reverse and no collector current flows. Any further increase in the a-c signal will produce a negative collector current. The parallel diode and resistor network prevent a-c voltage feedback to Q_1 because of unbalance between the two halves of the magnetic amplifier.

The control currents in coils A and B are always of the same polarity so the ampere-turns produced are always additive. The d-c normally present in A and B contributes to maintaining the core of the magnetic amplifier in a normally saturated condition.

Normally gate windings C and D are low impedance as a result of core saturation by the high current generated by the excitation voltage and the current in the control coils. As a result, a unipolar voltage normally appears across points X and Y, energizing the relay through the Zener diode. Excitation of the relay results in continuity of its contacts, which is a no-alarm condition.

When the a-c input to Q_1 reaches or rises above a value which causes cutoff and the collector current is either zero or negative, the flux in the core of the magnetic amplifier is reduced below saturation. The output impedance of the two windings becomes high and most of the excitation voltage drop is across the gate windings. This results in a sharp reduction of d-c output across points X and Y. When this voltage is reduced, the current through the Zener diode is sharply reduced causing the relay contacts to open and an alarm indication results. The alarm circuit may be used to automatically disengage the automatic pilot.

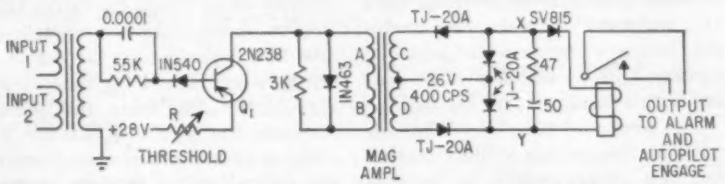


FIG. 5—Comparator-alarm circuit for system of Fig. 4 activates alarm or disengages automatic pilot if signals from dual accelerometers differ appreciably

Current flows during the normal or safe condition throughout the circuit. This practice not only insures that an alarm will be given in the event of power failure, but that open circuit faults that interrupt or diminish appreciably the current flow will also result in an alarm.

The Zener diode insures that the XY voltage required to drop out the relay is held above a minimum value compatible with fail-safe operation. Failure of any of the resistors, diodes, saturable reactors or the transistor, mixer transformer and connecting wiring that would result in open circuits incapacitating the monitor will cause the relay to revert to its deenergized position and give an alarm indication. Short circuits and breakdowns in magnetic components and in other vulnerable components that affect monitor operation also result in an alarm.

Technical Highlights

In this review of some of the interesting developments presented this year you will find—an electronic camera, an information storage system, computer simulation of video coding, a microwave signal generator and an S-band two-phase demodulator

By RONALD K. JURGEN, Associate Editor

TECHNICAL SESSIONS at a conference such as WESCON often pinpoint interesting developments in certain specific areas of electronics. This year, for example, electronic "photography" in one form or another was emphasized. In three papers to be reviewed here an electronic camera, a photographic system for information storage and television picture coding with a computer are discussed.

The pros and cons of backward-wave oscillators are subject matter for two other papers to be discussed. The first is concerned with a voltage-tunable backward-wave oscillator as the basis for a microwave signal generator. The second deals with an S-band two-phase demodulator for image rejection in which the outphasing principle is adopted in preference to use of a backward-wave oscillator.

Electronic Camera

In a paper by G. L. Clark of the Space Technology Laboratories, an electronic framing camera for millimicrosecond photography was described. The paper points out that observation of transient physical phenomena taking place in short time periods is often beyond the capabilities of conventional photographic techniques. In such cases, two basic types of high-speed camera are used. The first uses standard projection of a three-dimensional object onto a two-dimensional film. The second images a narrow strip of the object onto the film and moves the image across the film either mechanically or electrically during the exposure. This latter technique results in a two-dimensional display called a streak photograph. One axis is time and the other is distance along the strip.

The image-converter or electronic camera, shown in Fig. 1, operates as follows. Light from the object is focused by a lens onto the photocathode of an image-converter tube. Source of electrons is a photosensitive film deposited on the inside of the glass surface of the tube. Light strikes the film from the outside through the glass. Electrons are emitted on the inside transforming the optical image into an electron image. Accelerating voltage of 15 to 20 kv provides a radial electrical field to draw the emitted electrons away from the cathode.

Electrons carrying the picture information pass through a hole in the center of the anode into the field-free region beyond. There they move in nearly straight lines, coming to a focus on the fluorescent screen. An optical image is thus recreated on the screen where it can be photographed by forming an image on the film with another lens. A thin aluminum film over the phosphor keeps the emitted light from feeding back to the photocathode. This technique brightens the image.

To enhance the usefulness of the camera, electrodes were added. A gating grid, Fig. 1, is placed in the path of the beam. This grid serves as a shutter by permitting or preventing flow of electrons depending upon its instantaneous potential with respect to the photocathode. A negative voltage of about 100 v cuts the beam off. A positive voltage of 200 to 300 v turns the beam on and allows proper focus.

Deflection Plates

Another addition is a set of deflection plates provided at the crossover of the beam. These allow the image to be moved across the fluorescent screen. Deflection sensitivity varies from 900 to 1,850 v/in. An electrode is added for focusing which requires 1,500 to 2,000 v.

If a rapid sequence of frames is desired, it may be obtained by gating the beam on more than once. At the same time, voltages are applied to the deflection plates to move the position of the image on the fluorescent screen so as to form a

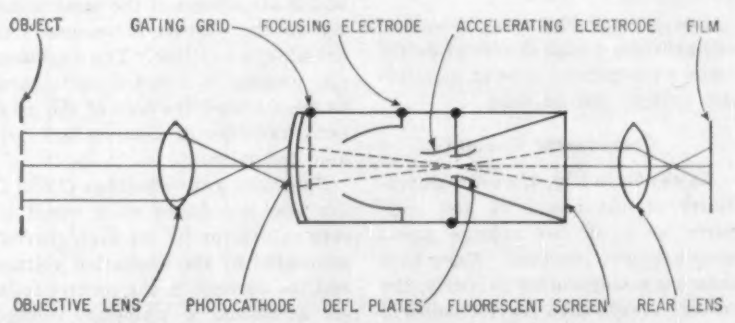


FIG. 1—Ray diagram of electronic camera shows operating principle

of '58 WESCON

series of images side by side. Since the screen is imaged on a stationary photographic film, successive images also appear side by side on the film.

If streak photography is desired, the grid is pulsed positive for the duration of the exposure while the image is deflected rapidly across the screen by a ramp voltage wave applied to one deflection plate. If desired, ramps of opposite polarity can be applied to the two plates. The sweep is timed to begin before the gate pulse and last longer than the exposure and is linear during the entire exposure.

Information Storage

Microspace, as defined by S. P. Newberry of General Electric, is the minute detail of solid surface which is too small to be related causally to the gross structure of the solid and too small to be located by mechanical means. The electron microscope shows the greatest promise for making use of microspace for information storage.

To utilize microspace, certain factors must be realized. First, the entire storage surface can be placed inside a vacuum or hermetically sealed space. Second, serial searching is not necessary because of the small storage area. Third, mechanical motion at reasonable speeds to any part of the memory requires only a fraction of a second. Fourth, mechanical positioning may be approximate as long as it is stable. Final scanning and centering-in can be done optically or electron-optically. Fifth, redundancy can be employed to insure reliability because of the large capacity. Sixth, the high speed of optical readout permits built-up addressing of the information.

An entire memory can be placed on a simple continuous surface such as a plate, drum or disk. Light optics for readout has the advantages of simplicity, low cost and use of color. Maximum practical storage density is about 10^9 bits/cm^2. One hundred sheets, 32 by 32 cm, would exceed the storage capacity of the human brain. Electron optics, on the other hand, offers high resolution. An electron microscope can read easily 10^{13} bits/cm^2.

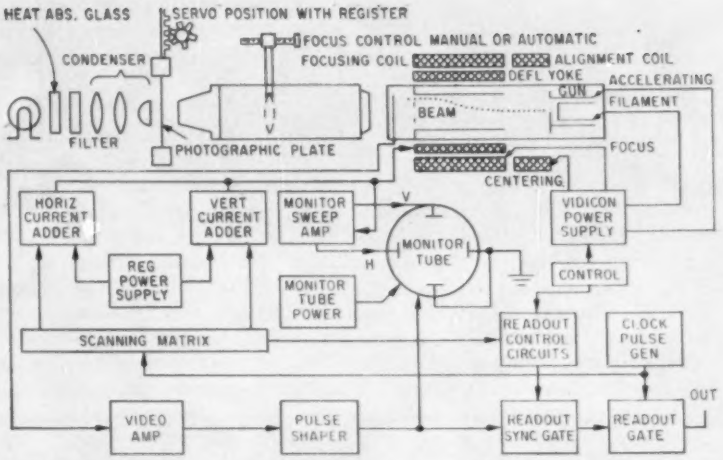


FIG. 2—Microspace storage system illustrated uses a photographic plate for storage. Information is projected onto face of vidicon

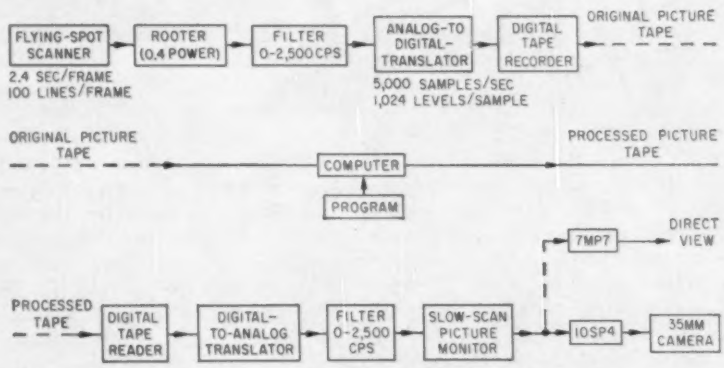


FIG. 3—Picture coding by computer simulation encompasses components shown

Photographic Analogy

For ease in understanding, the concept can be illustrated best by a system based on the more familiar and less complex light microscope and ordinary photographic film as the recording medium. Figure 2 illustrates the basic components of such a system. Data are stored by two stages of photographic reduction—through an enlarger in reverse and then through a microscope in reverse—onto a Kodak high-resolution photographic plate. The plate has a slow speed which is the reason for a two-stage reduction system allowing individual bits to be exposed on fast large-grain film with a flying-spot scanner. Storage on the slow fine-grained emulsion can be made in large parallel groups. In this manner, 10^9 bits can be stored in about one-half hour exclusive of processing time.

The photographic plate containing digital information is positioned by a servo to the approximate location where a desired block of information is stored. The data block is focused somewhere within the linear area of a vidicon tube face. Scan of the vidicon can be centered electronically onto the image of the data block wherever it may fall. Servo control is in the x and y directions only. Data may be

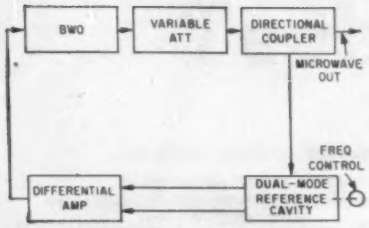


FIG. 4—Simplified block diagram of basic microwave signal source

read from the vidicon in the same manner as with an electrostatic memory tube. Or data may be read out serially to a core memory to avoid deflection uncertainties. Bit spacing chosen was eight microns between centers. Each block consisted of a 64 by 64 matrix (4,096 bits per data block).

The system is extended easily to a drum or disk. Using standard 4 by 5-in. photographic plates, as another alternative, and a "record-changer-type" mechanism, as much information can be stored as with 50 of the largest capacity memories available. Photography is limited to file-type memories because of the processing delay.

Spot Size

For electron-optical microspace storage systems, one problem has been that the electron beam scatters within the material of the recording surface. Size of the recorded spot may be many times larger than the electron-beam diameter. Several possibilities exist for circumventing this problem. One is to substitute positive-ion beams for electron beams. Penetration is then less by roughly the ratio of the square roots of the masses—a factor of 43 for electrons to protons and even greater for heavier ions. Another technique is to use a surface which only records where the electrons enter and not where they go under the surface nor where they may emerge.

Picture Simulation

In a system described by R. E. Graham and J. L. Kelly, Jr., of Bell Telephone Laboratories, a general-purpose computer, the IBM-704, is used as an instrument for simulating video coding methods. Outstanding advantage of the system is flexibility. One disadvantage is slowness. To hold machine time and storage requirements to a reasonable size, the simulation system uses an input picture of about 100 by 100 elements. This corresponds to about 1/25th of a conventional tv frame.

A block diagram of the picture processing chain is shown in Fig. 3. It was decided that a picture consisting of 12,000 samples would be a good compromise between scanning time, machine time and machine storage on the one hand, and size and resolution of the picture on the other. A DuMont multiscanner was converted to scan a square picture in 2.4 sec with 100 scanning lines. The resulting video signal is rooted, mixed with sync in the conventional manner and band-limited to 2,500 cps. The video signal is then fed into the digital recording equipment consisting of an Ampex 300 audio transport operated at a tape speed of 50 in./sec. The sync generator is triggered by counting down from the 5-kc timing wave used to trigger the digital gear. Recording is started during vertical blanking.

Usually, several frames of a given picture are recorded to allow for monitor setup time in playback. Recording is stopped asynchronously, the picture changed in the scanner, and a file mark recorded before each succeeding picture. These operations are accomplished by a combination of relay and electronic logic.

When a tape is played back, the Datrac converter changes the signal from digital to analog. The signal is passed through a low-pass filter identical to the recording filter and displayed on a monitor. The sync pulses are derived from the video signal and the timing wave from the tape is used to control the horizontal sweep speed. The monitor has two kinescopes—a seven-in. tube with a slow phosphor for direct viewing and a 10-in. tube for photographing with a 35-mm camera.

At the present time, the system has been used only for testing of digital coding systems. It is planned, however, to use it for simulation of analog signal processes and also for more elaborate computations on visual material, including pattern recognition.

Microwave Signal Generator

Either a backward-wave oscillator or a Carcinatron may be used in a microwave signal generator in which frequency is controlled by adjusting a single voltage. In the generator described by J. A. Huie

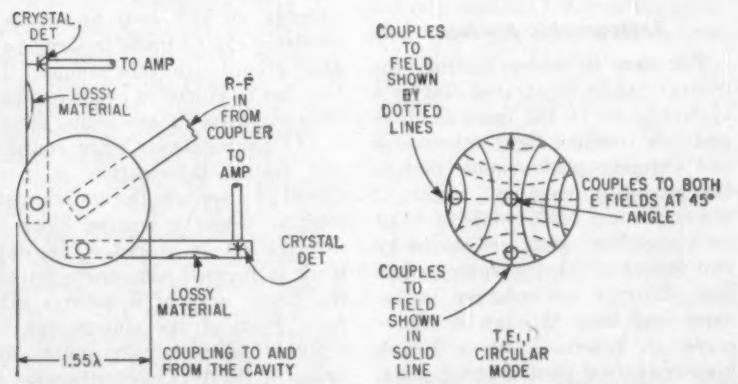


FIG. 5—Reference cavity of microwave signal source (left) and mode representation of the cavity (right)

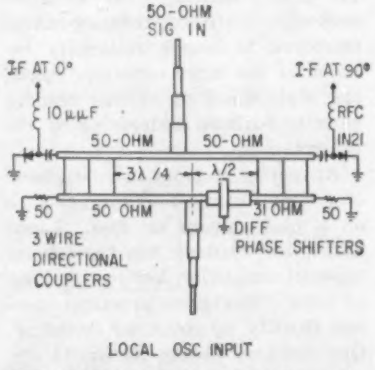


FIG. 6—Schematic representation of S-band two-phase demodulator

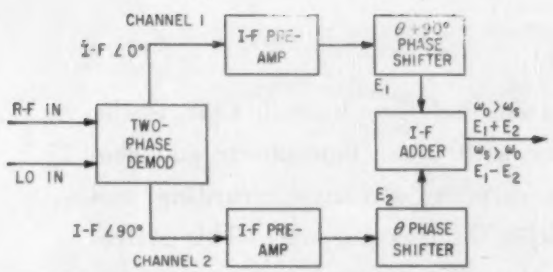


FIG. 7—Basic image-rejection receiver with phase relationships

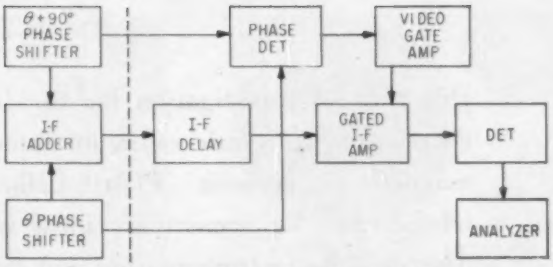


FIG. 8—Additional stages for increased image rejection

and L. C. Eisaman of Stromberg-Carlson no mechanical elements have to be adjusted or tuned. Degree of precision depends upon accurate electrode voltages.

Basic System

The basic system is shown in Fig. 4. The voltage-tunable bwo is used to derive a c-w microwave signal. The r-f power is sampled by the directional coupler and fed to the reference cavity. Frequency of oscillation is controlled by one-knob tuning of the precision reference cavity. The variable attenuator adjusts the r-f level and provides a service adjustment to compensate for variation between microwave tubes. This variation should be reduced to standardize the loop gain at an optimum value by adjusting the input power to the reference cavity. If power output must be held constant as a function of frequency, the attenuator can be automatically controlled.

Signals are furnished to the differential amplifier by the reference cavity in such a manner as to stabilize the system. A dual mode cavity with two resonant points a few mc apart gives the proper response. Both modes track over the complete tuning range of the cavity. Figure 5 shows the modes and a schematic representation of the cavity. In order to couple to both modes with the input line, the $TE_{1,1}$ circular mode was chosen. Outputs are separate for each resonance mode. A coupling similar to a sidewall waveguide coupler was employed with waveguide input and output. The input couples through the center hole and excites both modes.

Two tuning screws, 90 deg apart on the periphery of the cavity, set the distance between the two resonance modes. If properly adjusted, a smooth discriminator-type output over the operating frequency range is provided by the difference of the two outputs. The cavity has a loaded Q of about 3,500 for each resonance mode.

Absolute frequency accuracy of 0.03 percent was achieved. At C band, or 5 kmc, this is a 1.5-mc accuracy. Short-term frequency stability was less than one part in 10^5. Residual f-m was one part in 10^6. With a Raytheon QK522, power output obtainable is in excess of 150 mw. The generator is tuned readily over a 15-percent band.

Some of the potential applications for the microwave signal source include: secondary microwave frequency standard; driver for traveling-wave tubes; radome thickness measurements; Q measurements on microwave components; dielectric or phase-shift component measurements and calibrating frequency meters.

Two-Phase Demodulator

In development of an S-band demodulator to provide image rejection, R. B. Wilds of Sylvania Electronic Defense Laboratory considered using a bwo but decided instead to adopt a system based on the outphasing principle. Difficulty in synchronous tuning of the bwo was the reason for its elimination.

The r-f demodulator is shown in Fig. 6. It consists of two two-way power dividers, two 10-db directional couplers, two 1N21 crystals and a phase-corrective network. Antenna and local-oscillator signals are split into equal components at the power dividers. Before mixing, one component of the local oscillator signal is delayed 90 deg with respect to the other. But components of the incoming signal are kept in phase. Purpose of the corrective network is to maintain the 90-deg phase difference in local-oscillator branch line lengths over the octave bandwidth. Directional couplers serve dual purposes—they are part of the mixer circuit (local oscillator injection) and they provide isolation between the separate local-oscillator signal components.

Receiver

The image rejection receiver is shown in Fig. 7. Output voltage of channel one lags that of channel two by 90 deg when the local-oscillator frequency is higher than the signal frequency. When the l-o frequency is lower than the signal frequency, output of channel one leads channel two by 90 deg.

Since the amount of image rejection realized by basic outphasing is limited, the receiver of Fig. 7 was modified by adding additional stages as shown in Fig. 8. The phase detector is arranged so that positive output pulses are generated in response to the signal and negative ones in response to an image. The positive pulses are ignored while the negative ones are amplified in the high-gain video gate amplifier. Amplified pulses are applied to the gated stages in the gated i-f amplifier. Gain of the i-f amplifier is reduced as the number of gating stages increases.

The image rejection receiver reduces interference in localities of high signal density. The system could also be useful for eliminating or reducing image noise band when using a traveling-wave tube preamplifier. Variations of the basic principles can possibly solve other signal ambiguity problems in superheterodyne receivers. To adapt the receiver to other r-f bands, the demodulator can be rescaled.

One field of investigation for the International Geophysical Year is the correlation of cosmic radiation intensity with other ionospheric and geomagnetic phenomena. Plastic balloons carrying sensitive recording and telemetering equipment are ideal vehicles for this purpose. This article describes the instrumentation and transistor circuits employed

By L. E. PETERSON, R. L. HOWARD and J. E. WINCKLER,
Institute of Technology, University of Minnesota, Minneapolis, Minn.

Balloon Gear Monitors

DURING THE International Geophysical Year, changes in the intensity and composition of cosmic radiation will be correlated with sunspot activity, solar flares, and related ionspheric and geomagnetic effects. To measure low-energy cosmic rays effectively, it is necessary to place detectors above the earth's atmosphere for extended periods of time. Constant-level plastic balloons provide an ideal vehicle for this purpose. Apparatus flown on such balloons must meet severe restrictions as to weight and power consumption, and must withstand extreme environmental conditions, yet provide the utmost in reliability.

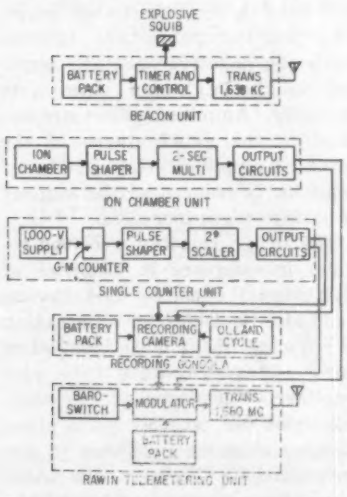


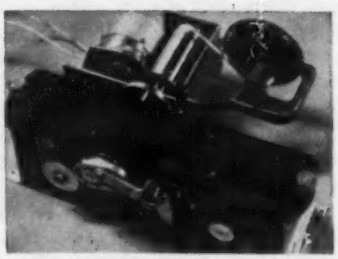
FIG. 1—Block diagram of the flight equipment using Rawin telemetering and tracking. Information rates to be recorded and telemetered are reduced to the minimum for simplicity of recording and to increase telemetry signal-to-noise ratios with a minimum of power.

Instrumentation

Minimum scientific instrumentation consistent with the objectives of the program consists of a single omnidirectional Geiger counter and a spherical integrating ionization chamber.[1] The counter measures the particle or X-ray flux while the ion chamber measures the energy loss of the radiation in the chamber. The ratios of ionization rate to counter rate are important pieces of data. The responses of each instrument to varying types of radiation are calibrated under laboratory conditions in advance of the flight.

A nuclear emulsion pellicle, consisting of 12 4-in. by 5-in. by 600-micron Ilford plates, completes the detecting components of the flight train. From these plates, the energy and charge spectra of cosmic rays may be determined.

The remainder of the flight instrumentation consists of recording and telemetering facilities, a pressure-altitude instrument, and devices for balloon programming



Time-lapse camera and Olland cycle pressure transducer assembly. Bellows moves contactor over rotating helix as pressure changes, varying phase of pips recorded on film

Telemetering is accomplished during the early phases of a flight by either one of two basic systems. One is based on the Rawin system[2] used by the Weather Bureau for radiosonde balloon flights. An alternate f-m/f-m system, using a carrier frequency of 95 mc, has been used for shipboard operations and at other naval installations where Rawin receiving facilities are not available.

The block diagram of the flight equipment using the Rawin system

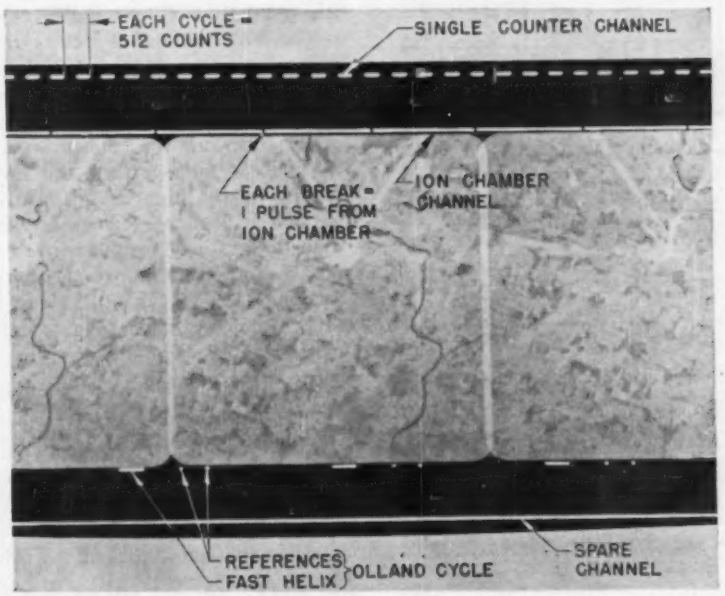
Complete ion chamber assembly. Copper-plated steel sphere is filled with pure argon at 100 psi

THE FRONT COVER—Plastic balloon being prepared for launching into space to measure cosmic-ray intensity

Cosmic Radiation

is shown in Fig. 1. The detailed circuits are in Fig. 2. The apparatus uses ordinary germanium transistors throughout except for the h-f transmitting tubes.

The output of the quartz-fiber electrometer in the ionization chamber is a pulse of about 10^{-11} coulombs, occurring at rates up to several per minute, depending on the intensity of the ionizing radiation. This pulse is differentiated and coupled to an amplifier by a grounded-collector stage. The saturated amplifier provides a positive pulse of 4-v amplitude and 10-μsec duration. This pulse triggers a 2-sec monostable multivibrator, whose output drives a direct-coupled grounded-collector stage that supplies signals to the telemetering and recording units. The 270-v supply consists of nine 30-v hearing aid cells potted in Tackiwax. Since the electrometer draws negligible current, battery life is indefinite. The transistor circuit is constructed on a phenolic card and the entire assembly is in an aluminum box.



Film strip taken at a balloon height of 100,000 ft. The records are typical of the response to cosmic radiation over Minnesota during solar maximum. Each camera frame spans 100 sq mi on ground. Position of river indicates balloon drift in 3-min

Geiger Counter

High voltage for the operation of the Geiger counter is obtained from a transistorized power supply and 1-kv corona-type regulator. The counter provides a negative pulse which is differentiated, shaped and amplified in a circuit similar to that of the ion chamber. The counter rate is scaled down by a 9-stage binary scaler before the square-wave output is fed to the telemetering unit. The circuits are built on an insulated card.

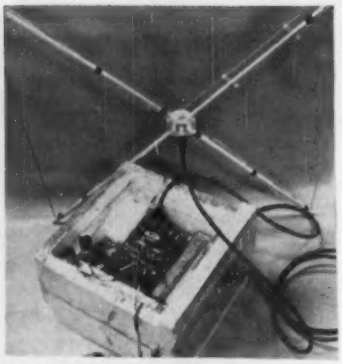
To prevent breakdown from high voltages at the low pressure of high altitudes, the instrument is sealed in a No. 10 can at 0.5 atmosphere.

Recording is accomplished with a

35-mm time-lapse camera which photographs downward so that balloon trajectories and upper-altitude wind velocities may be obtained from the aerial photos. Neon bulbs are placed near the edges of the film carriages and record on the film through small holes. The bulbs are turned off by negative excursions of the output grounded-collector circuits on each instrument. The circuit configuration of the neon drivers allows the 60-v bulbs to be turned on and off with low-voltage transistors. The brightness is independent of transistor characteristics. The film speed is held constant to within 0.1 percent by a chronometric motor. With a frame rate of 3 min per frame, a 50-ft roll of film provides continuous data recording for 35 hours.

To provide an altitude history of the flight, a pressure bellows and an Olland cycle readout are built into the camera unit. The Olland cycle transducer consists of a silver rotor, driven by the camera motor, with plastic-filled reference grooves and helixes. Each rotation of the rotor turns the neon bulb on and off in a definite sequence, depending on the position of the bellows-driven contact arm. The phases of the pips representing the 10-turn and 1-turn helixes are calibrated as a function of pressure previous to the flight. The camera is mounted in a lightweight frame with a two-pound battery pack which powers the recorder and instruments for 40 hr.

In the telemetering transmitter and modulator system, a 1,680-mc carrier is keyed off for about 65 μsec by a blocking oscillator whose frequency may be controlled by resistances or voltages in the grid circuit. The rate may vary from 2 to 190 cps. In meteorological applications, the rate is controlled by thermistors and humidity elements; for IGY flights these are replaced by information from the ion chamber and Geiger counter. The ground equipment consists of a servo-driven parabolic antenna, a 1,680-mc receiver, and a pulse shaper. These pulses provide the signal for a strip-chart recorder which has an output indication proportional to frequency. Azimuth and elevation are printed as a function of time.



Telemetering equipment operating at 95-mc packaged for flight

The water-activated wet battery normally used with the radiosonde equipment is replaced by a dry cell pack which lasts about five hours. After this time the balloon is usually out of range. Thus the early portion of the flight is telemetered so that balloon performance, wind data and approximate trajectory may be obtained before the flight terminates. Also, a quick look at the data is available to guide the programming of additional flights without the necessity of recovery.

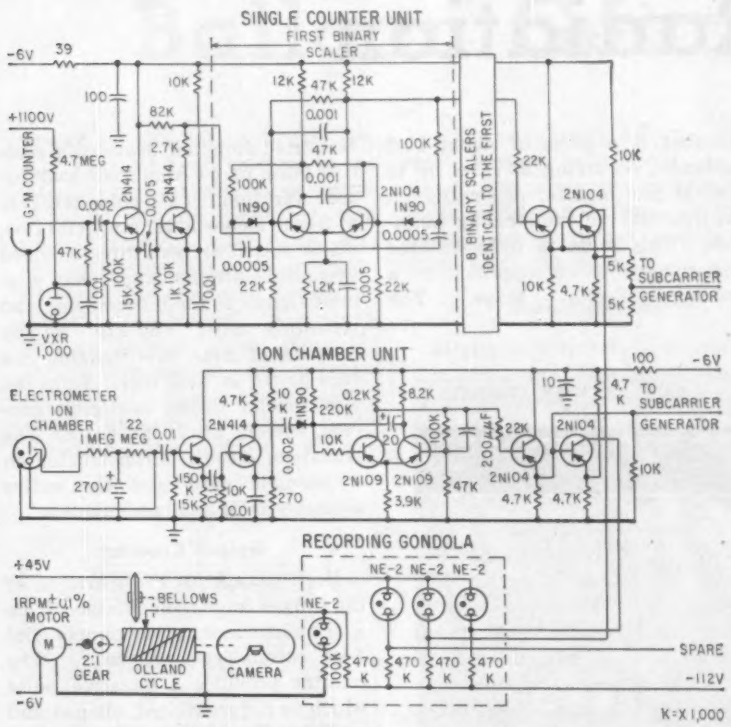


FIG. 2—Circuit schematic of the cosmic ray detection and counting circuits. Equipment is designed to operate from +30C to −40C

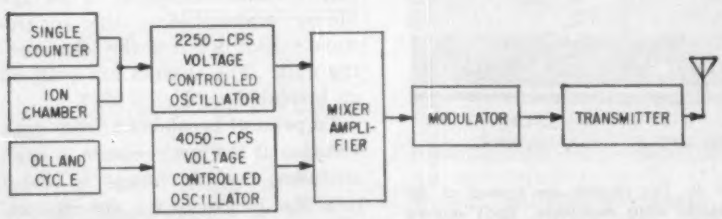


FIG. 3—Block diagram of the f-m/f-m telemetering system. Carrier frequency is 95 mc

Alternate System

The alternate balloon-borne f-m/f-m telemetering system is shown in the block diagram of Fig. 3, and the schematic in Fig. 4. The frequencies and amplitudes of the subcarrier generator circuits are held constant by temperature-compensation with thermistors. The 95-mc transmitter radiates about 0.5 w,

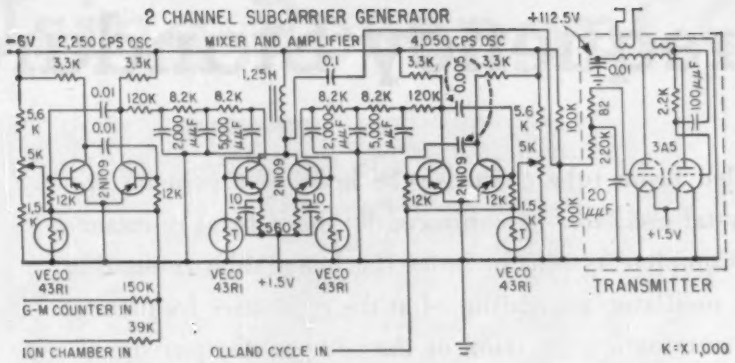


FIG. 4—Schematic of the two-channel f-m/f-m telemetering circuit. Output power is approximately 0.5 w; range is 400 miles

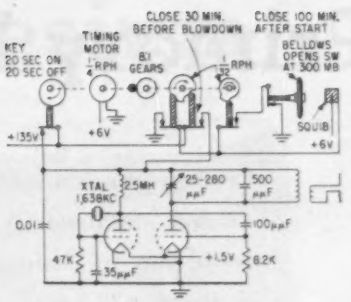


FIG. 5—Beacon and timer circuit. Squib explodes if balloon is at less than 30,000 ft 100 min after launching, thus eliminating hazard to aircraft. Battery pack supplies power for 40 hours

and can be received at 400-mile distances with an ordinary f-m/f-m ground station. Transmitter heat and water ballast are used to prevent freeze-out of the 20-hr battery pack. Field operations are simplified with this system since one can easily transport and set up an antenna, receiver and tape recorder.

A 1-w low-frequency beacon shown in Fig. 5 provides a signal for tracking aircraft and long range direction-finding. The unit also contains a timer and safety equipment satisfying CAA requirements on free balloon flights. Flight duration is set before launching, and at termination time an electrically controlled squib fires, freeing the load from the balloon; the balloon bursts and the load parachutes to the ground. The normal beacon signal of alternate 20-sec off-and-on periods is changed to a steady carrier a half hour before cutdown as an indication the timer is still operating and about to terminate the flight.

Flight Packaging

The individual transistor circuits are designed to operate between +30 C and −25 C, but since certain components such as the Geiger counter and dry batteries fail at low temperature special packaging is essential. Although temperatures at 100,000 ft may reach −70 C, the temperature of the batteries, counters and circuits does not drop much below the freezing point of water during an entire night. Painting the aluminum cans half white prevents excessive heating from solar radiation during the day. The radiosonde unit is wrapped in a double layer of rock wool and polyethylene plastic to prevent the batteries from freezing at night. The beacon unit is placed in a 2-in. thick Styrofoam box which retains the transmitter heat to warm the batteries.

The entire flight ensemble is shown in Fig. 6. The nuclear emulsions are sealed in a No. 10 can, and form the bottom component of the flight train. The low-frequency half-wave antenna is reinforced with 200-lb nylon line, and the entire load is lashed together with a 1,000-lb line. The total load weighs about 60 lbs and can be flown on a 60-lb balloon at constant level for periods up to 22 hrs at 10 mb pressure (100,000-ft altitude) without special ballasting.

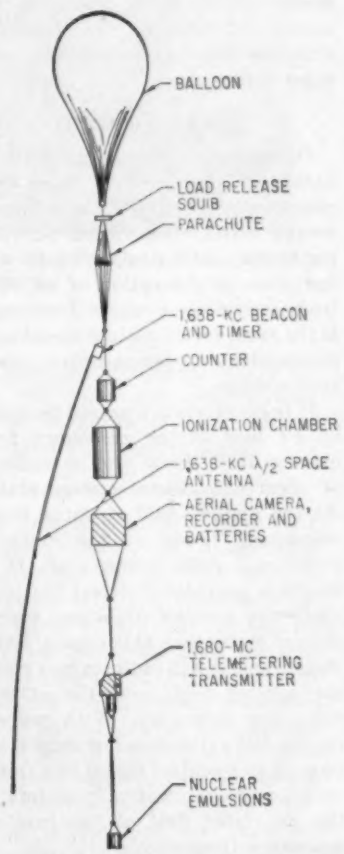


FIG. 6—Sketch of complete flight setup. Balloon has 180,000 cu ft capacity

Results

The apparatus has been flown on nearly 40 flights of up to 22 hours duration during the first half of the IGY. Only minor modifications have been necessary since the start of the flight schedule. This combination of equipment has proven flexible since it is possible to use either the Rawin or f-m/f-m telemetering scheme, or to fly it as a "hitch-hike" load without telemetry on much larger balloons. The spare data channel, readily available on the recording gondola or with either telemetering scheme, has been used for special apparatus, such as a photon counter.

Many of the electronic details in this work were developed by R. Maas. R. Thorness contributed to the mechanical design features of the instrumentation and W. Huch engineered the balloon features of the project.

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(1) H. V. Neher, *Rev Sci Inst.*, 24, p 99, 1953.
(2) T. F. Malone, "Compendium of Meteorology", p 1,207, Waverly Press, 1951.
(3) J. R. Winckler, L. Peterson, R. Arnoldy and R. Hoffman, X-Rays From Visible Aurorae at Minneapolis, *Phys Rev*, 110, p 1,221, 1958.

Primary Frequency Standard

Cesium atoms in a sealed beam tube comprise the heart of a primary frequency standard. A crystal oscillator is monitored by the natural resonance frequency of cesium. Complete system includes the beam tube resonating at 9,192.63184 mc, an oscillator generating r-f at the resonance frequency, and a control loop for automatic correction of the source. Output signals are 100 kc, and 1, 5, 10 and 100 mc, with accuracy of 1 part in 10^9

By W. A. MAINBERGER, National Company, Inc., Malden, Massachusetts

THE EXCEPTIONAL resonant-frequency stability of certain Group I atoms has been recognized and scrutinized for a long time. New techniques of evacuating a 6-ft long chamber, in which cesium may exhibit its resonance properties, have made possible a practical and reproducible primary frequency standard. The outstanding advantage of the new instrument is the long-term stability of its output frequencies.

At present this stability is rated at 5 parts in 10^{10}, when measured by a device having a response time of more than 5 sec. It is achieved at any time after a warmup of one hour, without reference to any other signal, and will remain the same throughout the life of the equipment. It also offers an accuracy of 1 part in 10^9, which is limited only by the precision of measurements of the resonance frequency of cesium. Its potential accuracy may not be realized until some future date.

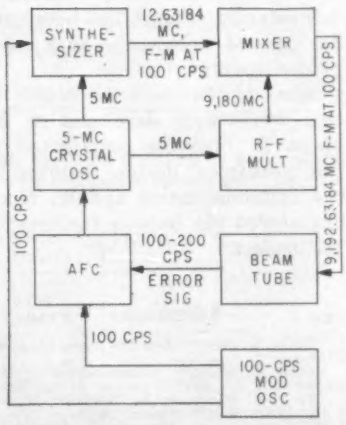


FIG. 1—System functional block diagram

System Concept

Operation of the Atomichron is based on the physical fact that cesium atoms can exist in different energy states. Transitions between states may be accompanied by the radiation or absorption of an electromagnetic wave whose frequency is the same for all cesium atoms and independent of temperature, pressure and age.

If these atoms are passed through an r-f field at the resonance frequency, it is likely that a number of them will change energy state. As the applied field deviates from resonance, fewer of the exposed atoms will make transitions. If a means is provided to detect continuously the number of atoms which change state, then this comparative measurement will indicate how close the applied field is to the atomic resonance frequency. With proper manipulation this measurement may be used as a control signal in a feedback loop to automatically maintain the generated field at the precise resonance frequency.

The instrument uses a 5-mc crystal oscillator as the prime generator of the r-f signal that is ultimately applied to the beam tube, as shown in the block diagram of Fig. 1. This 5-mc signal is multiplied 1,836 times to yield a signal at 9,180 mc. Simultaneously a group of multipliers, dividers and mixers synthesizes a signal of 12.631840 mc

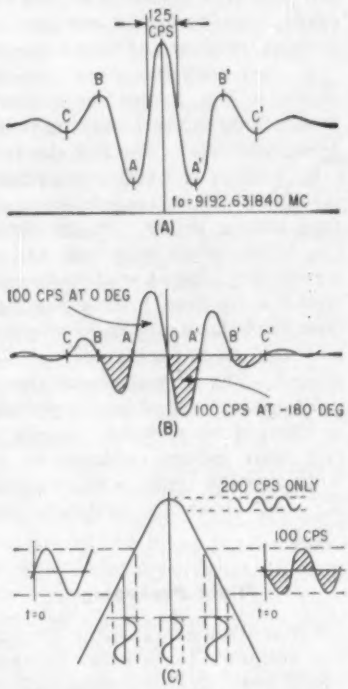
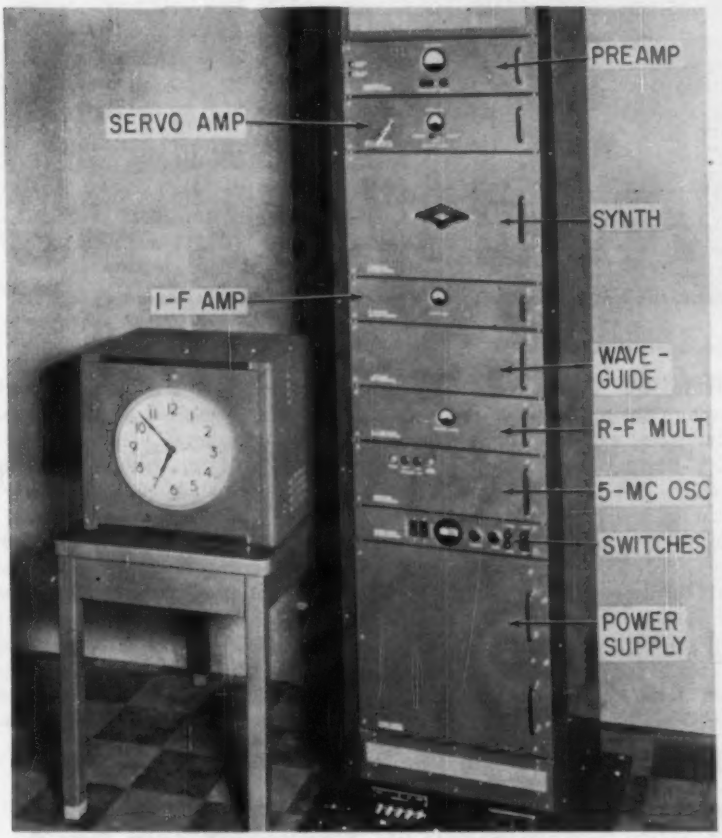
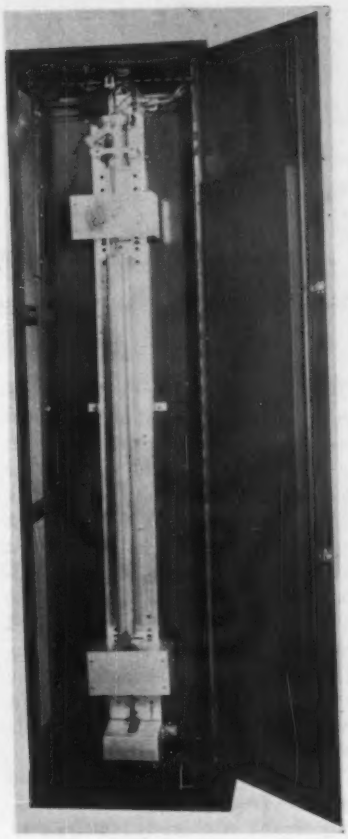


FIG. 2—Typical d-c (A) and a-c (B) resonance curves. Detection of 100-cps f-m signal is shown graphically at (C)

Using Resonant Cesium



Atomic clock driving standard electric clock with built-in 100-kc to 60-cps divider. Electric clock will lose only one second in thirty years.



Rear view of atomic frequency standard, showing beam tube construction

from the basic 5-mc source. These two signals are combined to produce the nominal resonance frequency of cesium, 9,192.631840 mc.

This frequency is exact only if the oscillator frequency is actually 5 mc. Since even the highest-quality crystals drift rapidly after the warmup period, it is necessary to determine the amount and direction of drift, and the correction to be applied through an afc system.

Any drift of the crystal oscillator is translated through the multiplier, synthesizer and mixer to the r-f field applied to the atomic beam tube. This tube is the comparison device of the feedback loop. Thus the drift of the crystal oscillator manifests itself as a reduction of output from the beam tube. The resultant d-c resonance curve of Fig. 2A does not discriminate against direction of drift, and is unsuitable as a control signal.

Frequency Modulation

By frequency modulating the r-f signal applied to the beam tube, however, the d-c resonance curve is converted into the discriminator-type curve of Fig. 2B. If the r-f decreases from resonance the output is an a-c signal of zero phase. A frequency increase from resonance yields an a-c signal of opposite phase. Not only has the direction of drift been resolved by this conversion, but the exact resonance frequency is identified as a true null rather than a maximum signal.

The signal from the beam tube is of proper form to control a servo system directly. A portion of the modulator output is fed to one winding of a 2-phase motor. The other winding is excited by the modulation detected by the beam tube. If a frequency difference exists between the 5-mc oscillator and the cesium resonance frequency, the control signal developed will apply a correction through a mechanically coupled capacitor and minimize the oscillator frequency error.

Synthesizer

The resonance frequency of cesium is not a convenient number to work with, and any basic frequency which will multiply to this value directly will not be an even number. For many applications

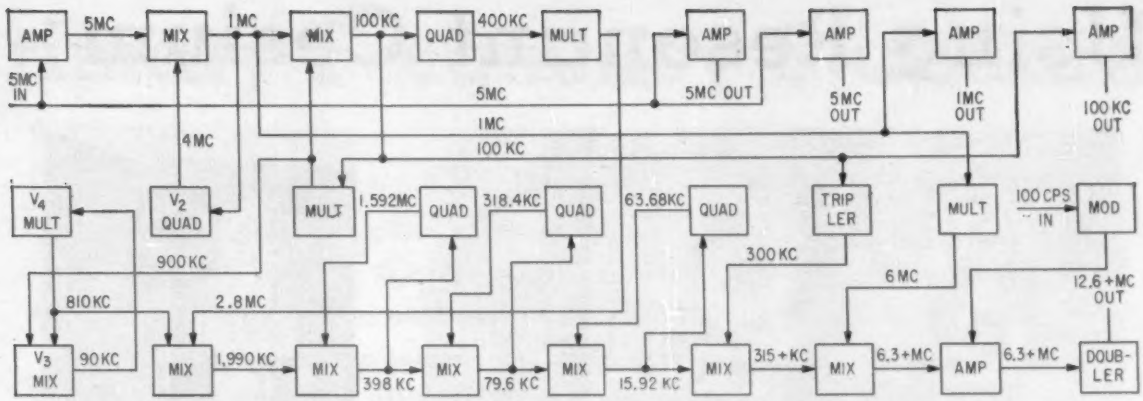


FIG. 3—Block diagram of synthesizer, which generates standard test frequency and a component of cesium resonance frequency

where stability alone is the consideration, availability of odd frequencies only presents no problem. But frequencies such as 100 kc and 1 mc have become standard in the field.

Starting with 5 mc as the prime generator, 9,180 mc is the easiest harmonic to achieve by direct multiplication. This leaves 12.631830 mc as the figure to be manufactured from a 5-mc source. All operations in the process must be such that the output will be an exact, invariant frequency with no drift and phase-locked to the input frequency.

The synthesizer performs this task by frequency multiplication, division and mixing. It is more convenient to synthesize 12.631840 mc rather than 12.631830. Since Essen's measurements[1] of cesium resonance are accurate only to ±10 cps, the accuracy is not impaired.

Dividers

All dividers in the block diagram of Fig. 3 are of the regenerative type and comprise a mixer and multiplier stage. A schematic of the input section is shown in Fig. 4. Using first divider V_1 and V_2 as a typical example, with the 5-mc input removed there will be no output. With the input replaced, any 4-mc signal across the output tank of multiplier V_2, due to noise or transient disturbance will mix with the input and create a 1-mc output which is multiplied to a greater 4-mc signal through V_2.

This regeneration continues until the loop gain stabilizes at unity. The design criteria for such a circuit are the conversion gain through the mixer times the multiplier gain, which must be greater than unity for the desired frequency, and the loop gain which must be less than unity for either the input or multiplier output frequencies. The higher the input level can be made without incurring oscillation, the easier the circuit will start.

Two signals are available from each divider. Thus in addition to the possibility of obtaining outputs of $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$ . . . from the mixers, values of $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$ . . . are simultaneously generated at the output of the multipliers. The synthesizer makes use of this to create 810 kc from 900 kc in a 10:1 divider, V_3 and V_4.

Supplying a phase-modulated frequency to the beam tube is also taken care of in the synthesizer, as shown in Fig. 5, since it is far easier to modulate 12.631840 mc and transfer the modulation to the X-band signal by mixing with 9,180 mc than to modulate 9,192+ mc directly.

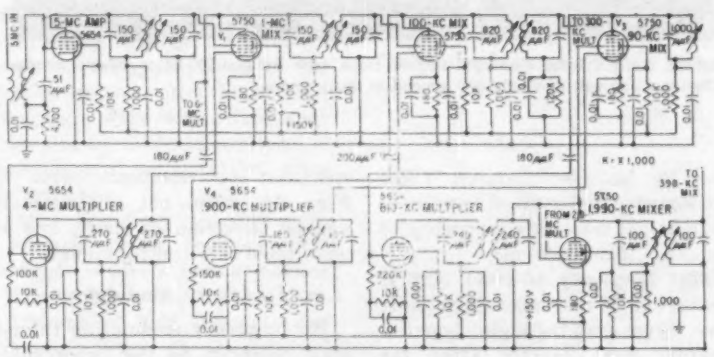


FIG. 4—Schematic diagram of input section of synthesizer

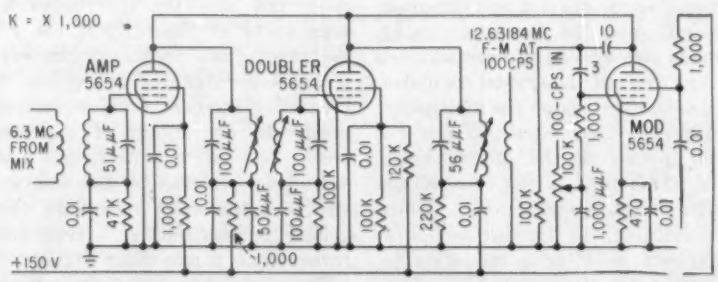
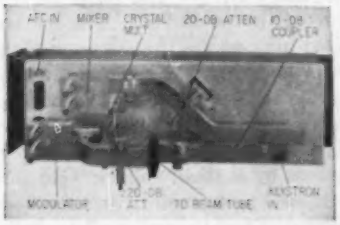


FIG. 5—Schematic diagram of modulator section of synthesizer

The 5-mc basic frequency is multiplied 108 times by conventional vacuum tubes to 540 mc at a level of 30 mw. This drives a 1N263 crystal multiplier and the seventeenth harmonic is extracted as 9,180 mc. Although this signal could be mixed directly with the synthesizer output to realize the required +9,192 mc, the available power would be far too small. To avoid using several traveling-wave amplifiers and degrading the signal with their attendant noise, the drift-canceled oscillator principle is employed.

Referring to Fig. 6, the output of a klystron local oscillator running at 9,147 mc is mixed with 9,180 mc to create a low frequency sideband of 33 mc. This is amplified by standard i-f techniques, with little degradation of the signal-to-noise ratio. The synthesizer output is injected into a high-level mixer in the i-f amplifier to obtain a 45.631840-mc signal frequency-modulated at 100 cps. When this output modulates the same klystron oscillator signal, the upper sideband becomes the required cesium resonance frequency, 9192.631840 mc.



Physical arrangement of waveguide

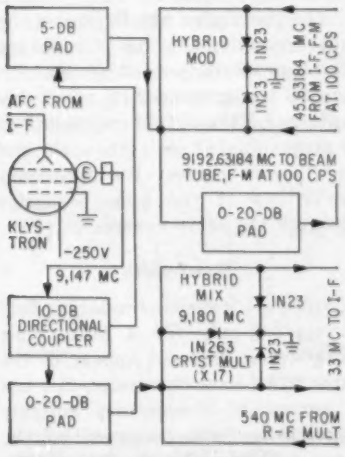
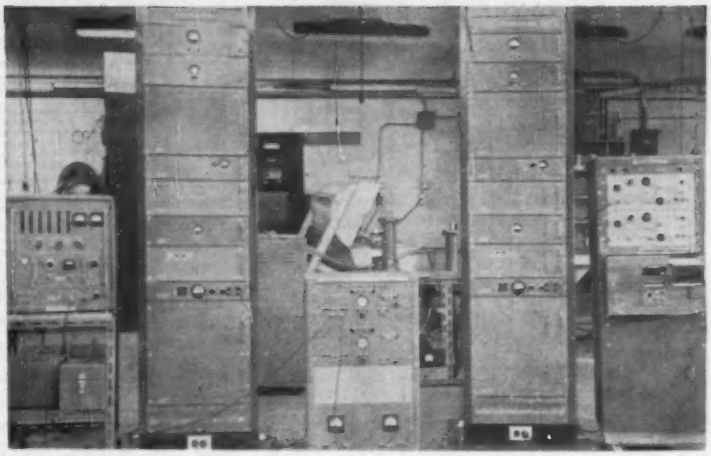


FIG. 6—Drift-canceled oscillator



Test setup for comparing stability of one atomic frequency standard against another

Frequency control of the 5-mc oscillator shown in Fig. 7 is accomplished by two motor-driven capacitors in parallel. Capacitor C_1 provides fine frequency control and is driven by the 100-cps control signal from the beam tube. This can vary the frequency ±2.5 cps, which is ample for short-term drifts over several days. To compensate for long-term shifts, larger capacitor C_2 is used. These two systems are interlocked electrically.

When the small capacitor reaches either end of its range, a cam closes S_1 or S_2 and energizes a relay which provides excitation to one phase of second drive motor M_1. The large capacitor begins to turn in the direction which will make the small capacitor return to the middle of its range. At this point the cam interrupts the relay circuit through S_3 and stops the control motor. This operation continues throughout the life of the equipment or until the long-term drift exceeds the automatic correction range of ±25 cps.

Control-Signal Amplification

The preamplifier shown in Fig. 8 amplifies the control-signal output of the beam tube to indicate proper operation of the system. The d-c component of the output is monitored on a meter connected between cathodes of the input amplifier, and indicates the resonance region as well as proper tuning of the tube's mass spectrometer. The 100-cps component at the plate of V_5 and supplied to the control-motor section of the servo amplifier. It is also amplified by V_5 and applied to a phase detector which receives a reference signal from the 100-cps oscillator in the servo amplifier. The detector output is d-c, whose amplitude and polarity depends on the frequency deviation of the system near resonance, as shown in Fig. 2C. This signal drives a zero-center microammeter for visual display, and is also available at a phone jack for driving an external recorder.

Warning

The 200-cps component of the beam tube output is extracted at the plate of V_6 of Fig. 8, and amplified to serve as signal for a warning circuit.

As seen in Fig. 2B the 200-cps component is maximum at resonance. By converting it into d-c, it drives V_7 into conduction and energizes relay K_1 to operate a green light. Should the system be off resonance or in other abnormal operating condition, the absence of 200 cps in the beam tube output will operate red warning light B_1.

The beam tube shown in Fig. 9 is the heart of the system. Its basic functions are to introduce cesium atoms into a vacuum chamber; pass them through a magnetic field of the proper frequency and discriminate against those which do not make transitions in energy state; detect the existence of the neutral atom and derive a useful output signal.

The oven is a closed chamber

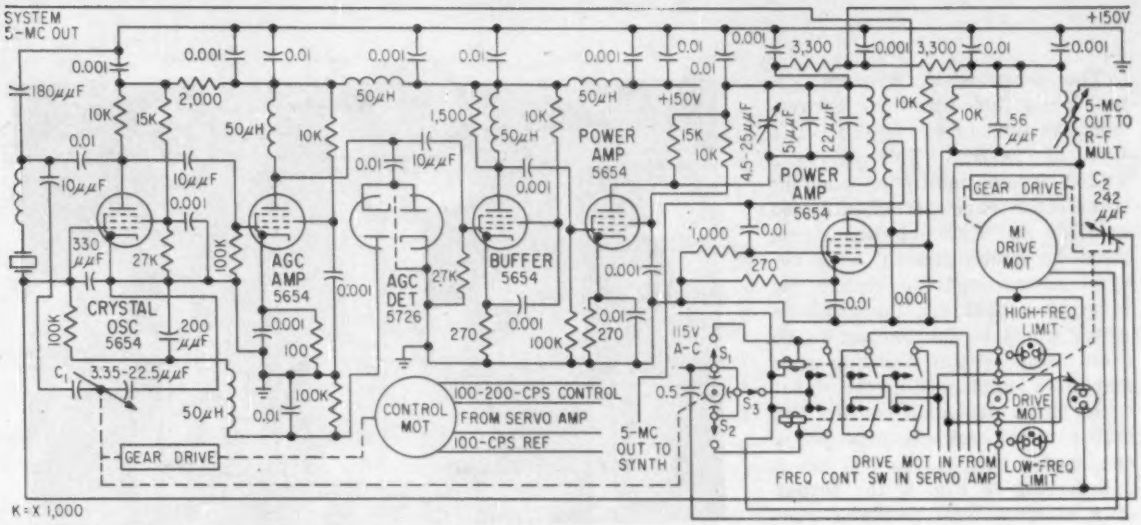


FIG. 7—Frequency of the 5-mc oscillator is controlled by a system of relays and motor-driven capacitors

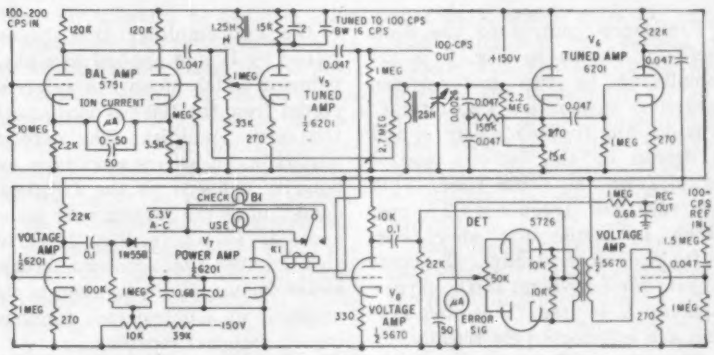


FIG. 8—Schematic of beam-tube preamplifier. Ion current meter is tuning indicator

within the vacuum containing a charge of metallic cesium. When heated to approximately 70 C the vapor of this element will effuse at a velocity corresponding to its thermal energy through a narrow aperture.

The atoms as they leave the oven exist in two energy states and are directed into a long narrow cylinder. Barring a collision with a residual gas atom, they travel in straight lines to the first of three magnetic fields. Here the particles interact with steady field *A* which has a strong gradient in a direction transverse to the beam direction.

The interaction of the atoms with this type of field, due to their magnetic dipole moment, is such that for one energy state the atoms are deflected slightly toward the larger magnetic pole piece, and for the other state are attracted toward the small pole piece. The two components of the beam are thus separated, and by bending the tube a small amount, atoms of one state only are directed along a path through the r-f field, as shown in Fig. 10.

In the central region of the tube the atoms interact with a combination of fields. One is a weak steady magnetic field and the other is the magnetic component of the externally generated wave at 9,192.631840 mc. The r-f energy is introduced through a glass window and travels through circular waveguide to a pair of r-f cavities which have slits to allow the passage of the beam. The oscillating magnetic field is confined to the r-f cavities, the rest of the structure being merely a drift space. If this field oscillates at nearly the correct frequency to satisfy the energy difference relation between the upper and lower atomic levels, the atoms will make a transition in state.

To sort out those atoms which have made transitions, and extract the desired signal the beam is next passed through strong inhomogeneous field *B* identical to the first one, and split again. Background noise is minimized by aiming the signal-carrying beam at a limiting aperture.

Detection

The cesium atoms as they pass through the detector aperture are neutral particles and must be converted into a current. The method used here makes the atoms impinge on a hot tungsten wire where they are adsorbed and quickly reevaporated as singly charged positive ions. The evaporating ions are drawn by a small electric field into a mass spectrometer, deflected, accelerated and then allowed to strike the first dynode plate of a 14-stage electron multiplier.

The multiplier amplifies the signal approximately 10^6 times and develops an output of several mv across the preamplifier input impedance. This output represents a control signal of such frequency and sign as to correct the frequency deviations of the 5-mc oscillator through the servo system.

Bandwidth

Since the transition-inducing field is applied only for a finite time duration, it does not appear to the atom to be monochromatic, but has a spread of frequencies roughly equal to half the reciprocal of the time duration. In the beam tube

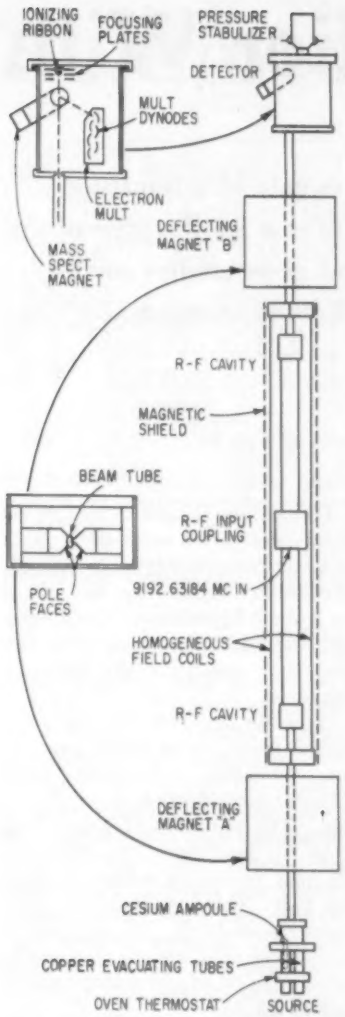


FIG. 9– Arrangement of beam tube

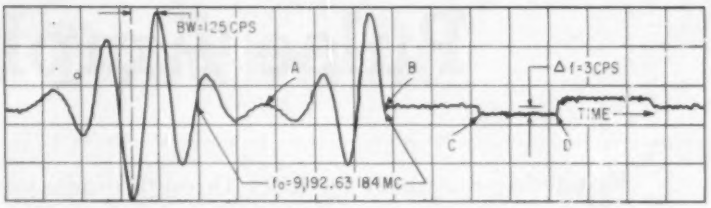


FIG. 11—Typical recording taken on atomic clock, when it goes through resonance is reversed at *A* and locked at *B*

the atom drifts through the transition region in approximately 5 millisec. The effective bandwidth is therefore 100 cps with an equivalent Q of 10^9. Furthermore, since the system operates on the derivative of the resonance curve, the resolution is increased markedly. The actual sensitivity is 1 mv of 100-cps error signal for each cycle off resonance at 9,192 mc.

In operation, about one hour is required to traverse the full frequency range. An accurate counter or other means will show if the frequency control switch was put in the proper position. Otherwise, the frequency will continue to shift away from resonance until one of the limit lights turns on and the drive motor is deenergized. When the switch is reversed, resonance will eventually be reached.

Then the ion-current meter shows a peak in beam current and the error-signal meter swings through zero several times, the deflections following a curve similar to Fig. 2C. The control switch is reversed and when the zero between the maximum peaks is reached, as in point $t = 0$ of Fig. 2C, the switch is put into the AUTO position and the control loop closed. All output frequencies now have the quoted accuracy and stability and they will retain them till the system fails or is shut down.

Performance

A typical recording taken on the system is shown in Fig. 11. The system was first driven through resonance, then reversed at point *A* and locked at *B*. Points *C* and *D* correspond to excitation of the drive motor while the loop is closed, causing the control capacitor to return to the middle of its range. The drive motor shifts the oscillator 20 cps/s at 9,192 + mc.

The slope at resonance is 1.5 cycles/mm. The velocity error introduced when the drive motor is energized at *C* and *D* is reduced to 2 mm or 3 cycles, corresponding to an output frequency change of 3 parts in 10^{10}. The loop gain is therefore about 20/3 or 6.6. System bandwidth is 125 cps.

Stability

By intercomparing systems at various times, actual reproducibility was determined to be 2 to 4 parts in 10^{10}. Stabilities over periods of several hours to a few days were always better than 5 parts in 10^{10} and often as good as 5 to 10 parts in 10^{11}.

Although over thirty Atomichrons are now in operation, the ultimate life of the beam tube is still uncertain for lack of sufficient data. Several are approaching or have passed the guaranteed life of 2,000 hours. One tube exceeded 4,000 hours of continuous operation before the vacuum deteriorated. The titanium getter was reflashed in the field, and an additional 1,500 hours of satisfactory operation have been accumulated to date.

A practical atomic primary frequency standard is now a reality, and this is just the beginning of a new approach. Many improvements indicated by prototype testing have already been incorporated into present production models. Next objectives are higher stabilities up to 1 part in 10^{11}, ruggedized equipment and airborne and missile models.

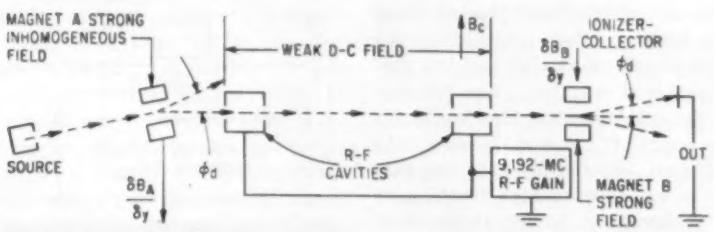


FIG. 10—Path of atoms through magnetic fields in beam tube. Deflection angle ϕ_d is usually small, about 0.01 radian

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Pulse Amplifier With

Fast-acting nonlinear feedback through diodes controls gain of a transistorized pulse amplifier. Output is essentially constant over a 38-db range of input signals. Two circuits are presented; the second gives greater small-signal gain than the first, as well as improved feedback limiting action

By LEON H. DULBERGER,
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Checking the gain of amplifier-limiter

CIRCUITS discussed in this article provide amplification of 100-kc square waves and feature the ability to limit output amplitude without introducing phase distortion. Amplification is present in varying amounts, determined by input level. For signals of 5-mv peak or less, 38 db of gain is provided, automatically diminishing for higher level input signals. With 400-mv peak input, gain is slightly over unity.

The standard approach calls for an amplifier and clipping diodes at the output as shown in Fig. 1A. However, for large outputs, the diodes do not provide complete or distortion free limiting. Because of physical factors within the diodes, signals above a critical amplitude have their leading and trailing edges shifted in time with respect to low-level position. If information contained on the leading edge, is used to trigger a multivibrator, false output will be generated.

An alternate approach, shown in Fig. 1B, employs nonlinear feedback to overcome the disadvantages noted, and still provides fast-acting control. A circuit using this method, is shown in Fig. 2A. Transistors Q_1 and Q_2 provide amplification, while Q_3 converts the output to a low impedance and contributes current gain to drive the emitter of Q_1. Diodes D_1 and D_2 are the nonlinear elements in the negative feedback loop. Before complete breakdown of the diodes, feedback over the amplifier is small, resulting in maximum gain. The only feedback present results from leakage resistance and stray capacitance of the diodes. By employing silicon switching types with large threshold voltages, and only 4 to 12 $\mu\mu$f of stray and junction capacitance, this feedback can be kept at a minimum. Potentiometer R_1 is set to produce zero d-c voltage across the diodes. It thus prevents conduction resulting from bias-level differences. When the output signal exceeds 0.4-v peak across the diodes, conduction begins.

Stability

To insure stability with the large amount of feedback present when the diodes conduct, attention to the rate of roll off at high and low frequencies is required. For low frequencies, staggering time constants by having C_1, C_2 and C_3 work into different impedances produces stability. Control of high frequencies is achieved by proper alpha-cutoff limits of the two transistor types used in the amplifier.

Transistors Q_1 and Q_2 are 30-mc alpha-cutoff drift units while Q_3 is an audio-frequency type, in grounded-collector connection to obtain low output impedance. Considered with the load impedances used, the final time constants are properly staggered.

Complete degeneration for large inputs, resulting in unity gain, is not realizable consistent with sufficient amplification of small signals. The necessity of keeping R_2 large for maximum loop feedback efficiency results in a loss of open-loop gain. This loss is due to local degeneration in Q_1. A compromise adjustment of R_2 results in a small-signal gain of 50 and a large-signal gain of 2.5.

An input signal of 5-mv peak is amplified to 250-mv peak at the output. A 400-mv peak signal emerges at a 1,000-mv peak level. Thus a 38-db input variation of signal level is held within an 8-db spread at the

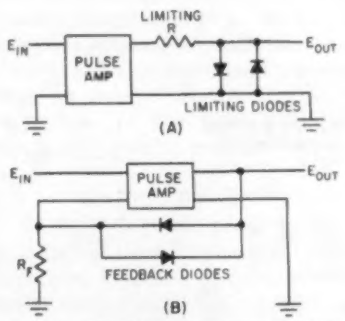


FIG. 1—Simplified schematics illustrate (A) standard limiting circuit and (B) nonlinear feedback limiting

Nonlinear Feedback

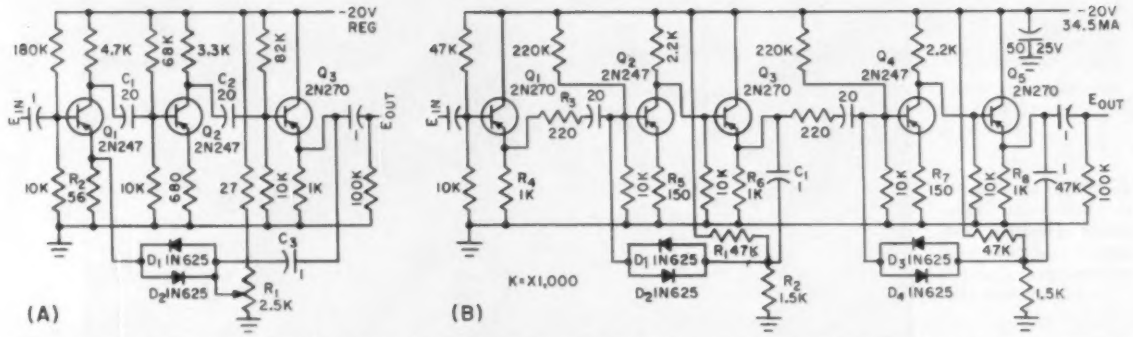


FIG. 2—Circuit diagrams of pulse amplifiers. (A) yields output variation of 8 db for input level variation of 38 db. In (B), feedback paths in two direct-coupled transistors pairs improve limiting action

output and small-signal gain is 34 db.

Improved Circuit

An improved version is shown in Fig. 2B. Greater small-signal gain is obtained, and feedback limiting action for large inputs is improved. In this circuit, Q_1 provides isolation of input circuits from the base of Q_2. The dynamic impedance of this base becomes low when large amounts of feedback are applied. Degeneration paths are provided separately in each of two direct-coupled pairs. In the first pair, consisting of Q_2 and Q_3, feedback is through two type 1N625 silicon diodes D_1 and D_2 to the base of Q_2. Zero d-c voltage across the diodes in the absence of signal is established by voltage divider R_1–R_2 in relation to the bias point of Q_2. Capacitor C_1 blocks the d-c emitter bias of Q_2. When the output signal of Q_2 is large enough, each diode conducts on alternate half-cycles, to an extent determined by the applied voltage. Resistor R_3 raises the impedance looking back into the emitter of Q_1 to a level which allows driving the base of Q_2 to full degeneration.

The grounded-emitter stage Q_2 employs a type 2N247 drift transistor to preserve wave shape at the operating frequency. No stringent requirements are imposed, as signal rise time measures one μsec for the system under study. Transistor Q_3 in grounded-collector connection is a 2N270 low-frequency type. It provides increased input impedance because of its high local degeneration.

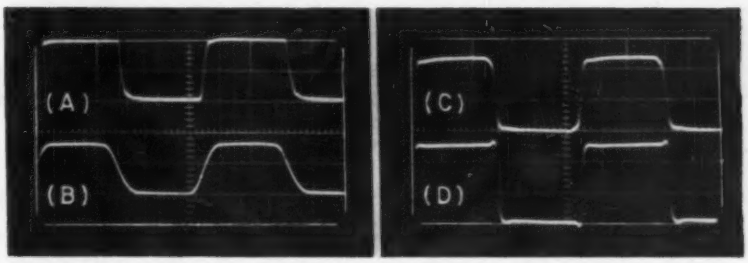


FIG. 3—100-kc input waveform (A) and resultant outputs. (B) shows output of 400-mv peak with 5-mv input. Waveforms (C) and (D) are 600-mv outputs at gains of 12 and 1.5, respectively

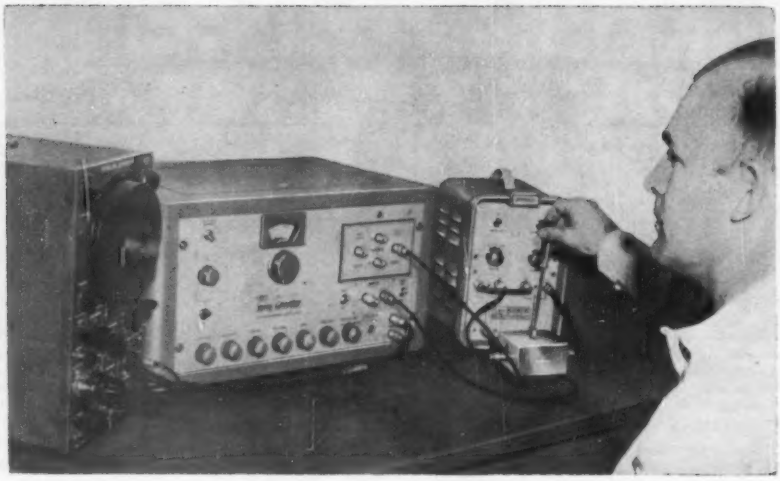
The second pair of transistors incorporates similar circuitry. The feedback condition is different however, for small inputs to Q_1. This is due to preamplification in the first pair. The resulting signal level causes conduction of D_3 and D_4. A large degree of feedback is therefore present in the second pair for most conditions of operation.

Wave Forms

Cascade connection of the two pairs results in full limiting action for large input signals. An input waveform at a level of 500-mv peak is shown in Fig. 3A, illustrating typical rise times accommodated. Figure 3B pictures an output signal of 400-mv peak when the input to the amplifier is 5-mv peak. Figures 3C and 3D show outputs of 600-mv peak each, for 50-mv and 400-mv peak input respectively. Small-signal gain is 80, midrange gain 12 and with a maximum input of 400-mv peak, gain is 1.5. For a 38-db input range, output variation is held within 3.5 db, small-signal gain is 38 db.

Temperature stability was obtained by the use of low-resistance bias dividers, and adequate local d-c emitter degeneration. Therefore, R_5 and R_7 (Fig. 2B) are kept relatively large. Resistors R_4, R_6 and R_8 provide full d-c degeneration. Checks for temperature stability were conducted with the amplifier operating at maximum gain. The output signal decreased 12 percent with a rise in temperature from 25C to 50C.

This design has proven effective as a fast acting limiter, even where the low-level gain feature is not required. It provides compression of sine or square waves with a minimum of phase distortion.



Technician lines up vhf tv equipment using sweep generator with coaxial switcher and oscilloscope

Broad-Band Generator Has

Versatile sweep generator for laboratory or production use has 100-kc to 300-mc sweep width over 200-kc to 1,000-mc center-frequency range. Two-stage agc amplifier keeps output flat ±0.5 db over 0.2 to 250-mc range and ±1.5 db from 230 to 1,000 mc

By CAYWOOD C. COOLEY, JR., Jerrold Electronics Corporation, Philadelphia, Pa.

DESIGN AND FACTORY test requirements for a wide variety of r-f circuits required a sweep generator capable of covering the frequency range 200 kc to 1,000 mc. In addition, the system design work required single-sweep coverage of the band 200 kc to 250 mc, flat within ±0.5 db, while filter design and other lossy circuit work up to 1,000 mc called for high output levels and a integral detector and preamplifier to facilitate measurements of −40 to −50 db.

Available equipment did not provide sufficient sweep width and also required purchase of three or four units to obtain complete sweep coverage of the desired spectrum. The unit developed to meet this need packages in one instrument most of the requirements for design and test applications and provides economies in dollars, bench space and logistics.

System Description

Figure 1 shows a block diagram of the major circuits.

A uhf oscillator is swept at a 60-cps rate with variable sweep width at center frequencies adjustable between 275 and 900 mc. Its output is connected through a 1,000-mc low-pass filter and agc monitoring circuits to the uhf output.

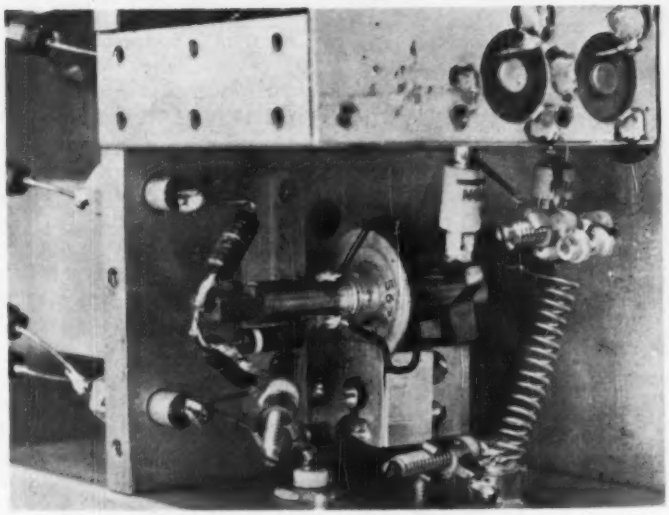
A second output is mixed in a crystal-diode mixer with the output of a 500-mc oscillator. The resulting difference-frequency components are passed through a 300-mc low-pass filter and agc circuit to the vhf output.

The d-c output of the appropriate agc monitoring diodes is connected to a high-gain d-c amplifier that controls the oscillation level of the sweeping oscillator. This forms a feedback loop acting to hold the output constant.

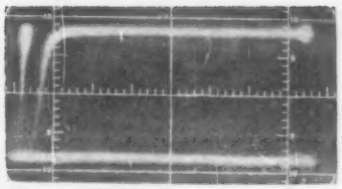
Blanking circuits key the oscillator off during either the forward or return trace if desired. Marker circuits mix signals from external c-w generators with the sweep signals, amplify the resulting beats and superimpose them as marker pips on the oscilloscope's vertical deflection signal.

A phase-adjustable voltage is provided for horizontal scope deflection.

In the sweep oscillator shown in Fig. 2, a pencil triode is used in a grounded-grid circuit in which the



Closeup view of uhf sweep frequency oscillator shows component arrangement



Waveform shows signal generator's output to be flat within ±0.5 db to 250 mc at extreme right of scale

Wide and Narrow Sweeps

plate is connected to the high side of the resonant circuit. The cathode is kept at a high impedance above ground by r-f chokes; a small capacitor connected between plate and cathode provides feedback coupling for efficient oscillation. For d-c the oscillator's plate is connected to the chassis, with current from a negative supply fed to the cathode through a 6Y6G agc amplifier. Control of the oscillation level is obtained by varying the grid voltage of the 6Y6G.

Controlling Resonance

The inductance in the oscillator's resonant circuit is a section of air-dielectric coaxial line. Its effective length, and thus the center frequency of the oscillator, is controlled by a short-circuiting plunger, providing low residual inductance. The line is rhodium plated internally to minimize contact wear.

The capacitance across the open end of the line is varied at a 60-cps rate by a wobbulator capacitor driven by a voice coil. The amplitude of its variation, and thus the sweep width, is set by the drive voltage applied to the coil. Since the moving plates mesh with a grounded set of plates at one end, and with a set of plates mounted on the center conductor of the line at the other, no flexible connection to the moving plates is required.

Sweep-Width Design

The extreme sweep width and wide range of center frequency desired dictated to a large extent the design of the oscillator. Of all the possible ways of obtaining frequency sweep, only the mechanically varied capacitor combined the required change of reactance with high Q at these frequencies. Only a coaxial inductor with a sliding short circuit provided the wide range of inductance variation (greater than 10 to 1) with no unwanted resonances and low losses.

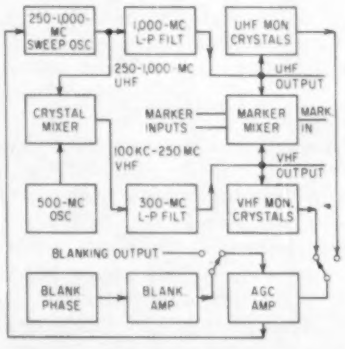


FIG. 1—Block diagram of agc and r-f sections of vhf-uhf sweep generator

A factor found to be of importance in obtaining satisfactory operation at frequencies near 1,000 mc was the effective series inductances of the oscillator and wobbulating capacitor. Adequate coverage of the high end was obtained only after these inductances were minimized and a pencil triode with low inductance connections was used.

In terms of the sweep circuits, the requirement of satisfactory operation at narrow sweeps implies that the instantaneous frequency of the uhf oscillator shall vary in the same manner as the oscilloscope's horizontal deflection (60-cps sinusoidal) for the small percentage variations. The motion of the wobbulator capacitor has an amplitude, for sweep widths of the order of 100 mc, of about 0.1 in.; for sweep widths of 100 kc, the amplitude is 1/1000 as great or only about 1/10,000 in.

To maintain satisfactory operation under these conditions required machining the essential parts from heavy brass pieces and a high degree of mechanical isolation, obtained by shock mounting

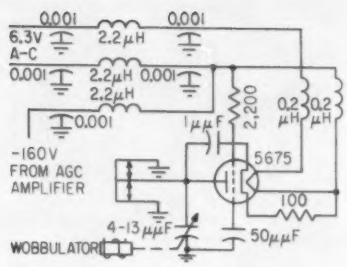


FIG. 2—Center frequency of uhf sweep oscillator is varied by sliding short

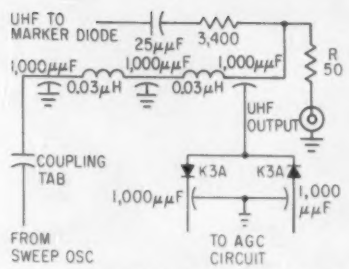


FIG. 3—Simplified schematic of uhf output circuit

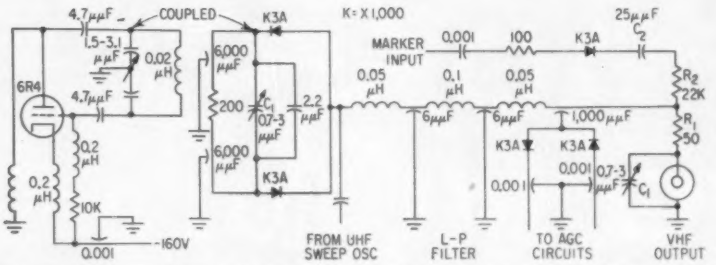


FIG. 4—Output of 500-mc fixed-frequency oscillator is mixed with uhf oscillator output to obtain vhf sweep output

the entire uhf oscillator assembly.

Other factors affecting narrow sweep operation are the ability to apply extremely small voltages to the voice coil, provided by the use of a fine bandwidth control and the exclusion of extraneous hum in the voice coil circuit by grounding it to the chassis at one point only.

UHF Output Circuit

As shown in Fig. 3, a small capacitance (tab) loosely couples the output from the oscillator plate. A low-pass filter, cutting off slightly above the high-frequency end of the oscillator's output range, minimizes harmonics in the output voltage.

At the output of the low-pass filter, two agc diodes provide voltage information to hold the voltage at this point constant, regardless of variations in the output of oscillator or in the load connected to the uhf output.

Since the voltage at this point is held constant by the agc circuit, the effective impedance seen looking back towards this point is low and a close match to any desired source impedance can be obtained by inserting the corresponding resistance R between this point and the uhf output connection.

Low-frequency output is obtained by beating the signal from the sweeping oscillator with that from a 500-mc fixed-frequency oscillator as shown in Fig. 4. To minimize direct energy transfer from one oscillator to the other, which would lock their frequencies together and prevent output at low beat frequencies, a hybrid type of mixer is used.

Two K3A silicon diodes are coupled in a balanced or push-pull mode to the fixed oscillator and in a single-ended or push-push mode to the sweeping oscillator. The push-pull connection is sharply resonant to the frequency of the fixed oscillator; while the push-push connection is nonresonant to operate over the range of the sweeping oscillator. By this technique, together with the use of 6,000-$\mu\mu$f button mica capacitors to bypass the 200-ohm mixer bias resistor, beat frequency output as low as 200 kc is obtained.

The beat frequency output of the mixer diodes is conducted through a low-pass filter which eliminates any uhf components and minimizes harmonics in the vhf output.

A matched source impedance, looking back from the vhf output connector, is obtained by inserting a suitable resistor R_1 at this point. A small amount of residual inductance is corrected by C_1 connected across the output.

AGC Circuits

Some of the vhf sweep signal at the agc point is coupled to the marker diode by R_2 and C_2.

The vhf monitoring diodes, D_1 and D_2, in Fig. 5, form a voltage-doubling rectifier that rectifies the r-f voltage at the vhf agc point, producing a d-c output in proportion to this r-f voltage. Circuit polarity is such that an increase in r-f voltage at the agc point results in a decrease in oscillator output. Thus the system is self-stabilizing.

The gain of the agc amplifier is made as high as possible, limited by a tendency to break into a-f oscillation at low output settings. The output voltage at which the system stabilizes is determined by the delay bias applied to the

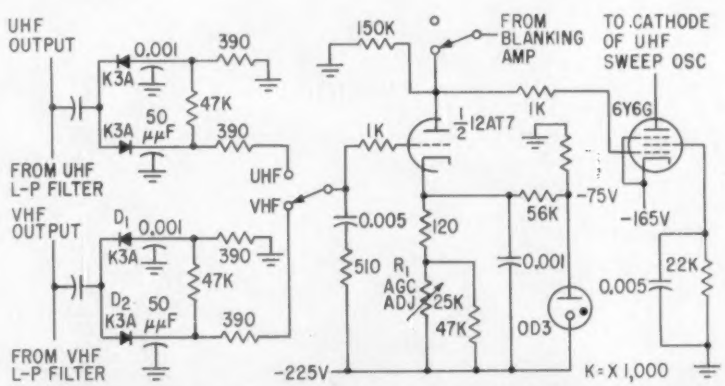


FIG. 5—Gain of agc amplifier is made high as possible without a-f oscillations at low output settings

cathode of the agc amplifier, which is controlled by R_1. This voltage is regulated by a gas tube to make the output voltage of the sweep unaffected by supply voltage variations.

Design for Flatness

With a high-gain agc amplifier, a high degree of regulating action can be obtained to hold the d-c output of the agc diodes almost precisely constant. Unfortunately, this holds the sweep r-f output constant only to the extent that the d-c output of the agc detector is a true measure of the r-f output. The r-f output is specifically the rms magnitude of the fundamental component. A diode with a long time-constant load responds approximately to the peak of the r-f voltage.

The presence of harmonics gives

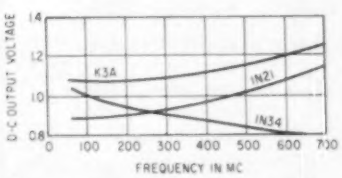


FIG. 6—Characteristics of monitoring diodes considered for use with agc circuit of Fig. 5

a false relation between rms input and d-c output from the detector. This difficulty is particularly severe with a half-wave detector. To minimize this trouble, and also to obtain nearly twice as much d-c for a given input, a full-wave detector is used. Since the d-c output is a measure of the peak-to-peak magnitude, it is not affected by small amounts of even harmonics.

Other steps taken to minimize this problem are the use of low-pass filters and the operation of the oscillators at levels where harmonics are low.

A second factor in obtaining flat output is the frequency response of the detectors. The K3A diode was selected for use in this sweep because, as illustrated in Fig. 6, it combines high efficiency, satisfactory frequency response, relatively high input impedance with a small change at various temperatures and consistent characteristics

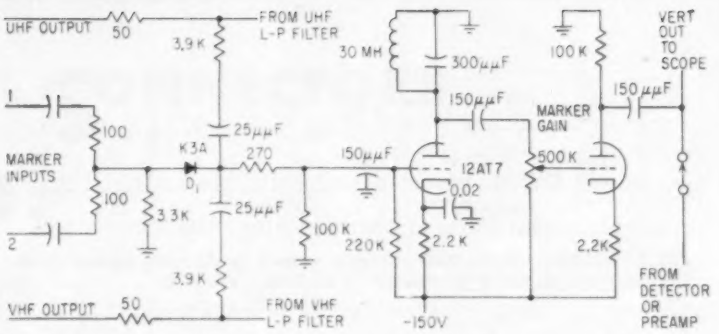


FIG. 7—Frequency-marker circuits can be used with either vhf or uhf operation

from one unit to another.

When the device being tested does not have its own detector, requiring use of a separate detector, flatness of the response as displayed is aided by detector matching.

It is more important in this case that the response of the agc detector and of the measuring detector agree, than that they be precisely flat. With similar detectors, when the response of the agc detector is 10 percent low at a certain frequency, the regulating action of the agc will make the sweep output 10 percent high at this frequency. If the response of the measuring detector at the end of the system is also 10 percent low, it will show this 10 percent rise as being flat.

Every effort has been made to make the detectors as flat as possible; as an additional safeguard, a measuring detector matched carefully to the agc detector is built into the sweep so that it is always available.

Frequency Markers

To provide for accurate and convenient frequency calibration of response curves the frequency marker injection circuits shown in Fig. 7 are built in.

A part of the uhf or vhf output is coupled through isolating circuits to marker diode D_1, which mixes this sweep voltage with single frequency signals from generators attached to either or both of the marker inputs. The resulting beat signals are applied to the first section of the 12AT7 marker amplifier. The plate circuit is resonated to a frequency of about 50 kc to provide a sharp peak of output as the marker beat goes through 50 kc and to reject all other frequencies.

Since the beat goes through this frequency twice each time the sweep passes a marked frequency, each frequency is marked by two closely spaced pips about 100 kc apart, that appear as one pip except on the narrowest bandwidth settings. This selectivity rejects low-frequency components in the output of the marker diode, due chiefly to the operation of the blanking circuit, which would otherwise cause distortion of the response curve at high marker gain settings and prevent marking with weak marker signals.

Detector and Scope Preamplifier

The diode load and r-c filter constants of the built-in detector are chosen to provide a good compromise between sensitivity and adequate a-f response to follow rapid changes in r-f frequency response. Filtering is sufficient so that only the lowest frequency components, below 100 kc, appear on the oscilloscope.

The detector output may connect to the input of a preamplifier that provides a gain of about 100. Inverse feedback stabilizes the gain and corrects for the coupling networks so that the low-frequency response is good enough to pass a 60-cps square wave.

With a selector switch in filter position, the input and output coupling capacitors, as well as constants in the preamplifier, are changed to give the amplifier a high-pass response rejecting frequencies below 1,000 cps.

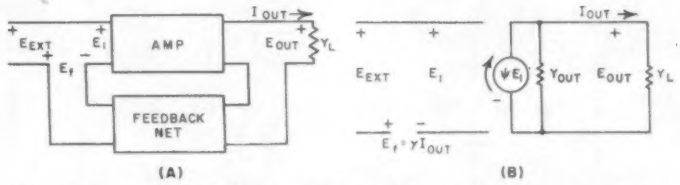


FIG. 1—Amplifier with feedback voltage in series with externally applied signal (A). Amplifier (A) can be represented by equivalent circuit (B)

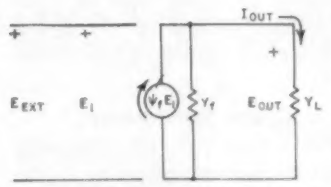


FIG. 2—Norton equivalent circuit with current feedback

Simplifying Current Feedback Analysis

Feedback-analysis parameters, similarly related to standard voltage-feedback relationships, are derived by using Norton equivalent circuit. Short-circuit transfer admittance ψ and output admittance Y_{out} of an amplifier without feedback are divided by the factor $(1-\gamma\psi)$

By **BERNARD M. ROSENHECK,** Hudson Laboratories, Columbia University, Dobbs Ferry, N. Y.

ANALYSIS of a voltage feedback amplifier using a Thevenin equivalent circuit[1] shows that feedback divides both open circuit voltage gain and output impedance of the amplifier without feedback by the factor $1 - \beta K$; where β is the feedback proportionality factor and K is the open circuit voltage gain of the amplifier without feedback.

If a Norton equivalent circuit represents a current feedback amplifier, then both short circuit transfer admittance and output admittance of the amplifier without feedback are also divided by the similar factor $1 - \gamma\psi$; where γ is the feedback proportionality factor and ψ is the short circuit transfer admittance of the amplifier without feedback.

In the amplifier shown in Fig. 1A feedback voltage is proportional to the output current of the amplifier. The factor of proportionality γ is defined by the relationship $E_f = \gamma I_{out}$.

Equivalent Circuit

An equivalent circuit is indicated in Fig. 1B. The short circuit transfer admittance without feedback ψ may be found by removing the externally applied signal and measuring the short circuit output current for input voltage E_i. The short circuit transfer admittance is then given as

$$\psi = I_{out}/E_i.$$

The output admittance Y_{out} without feedback is found by removing the externally applied signal and shorting E_i. Admittance Y_{out} is the admittance seen looking back into output terminals of the amplifier. The definitions of ψ and Y_{out} take into account the loading effect of the feedback network in series with the amplifier output.

The Norton equivalent circuit of the amplifier with feedback is indicated in Fig. 2. When output voltage E_{out} is shorted, output current $I_{sc} = \psi E_i$ in Fig. 1B. But $E_i = E_{ext} + \gamma I_{sc}$. Therefore $I_{sc} = \psi E_{in}/(1 - \gamma\psi)$. From Fig. 2, $I_{sc} = \psi_f E_i = \psi_f E_{ext}$ with output shorted. When output currents of the two circuits under shorted conditions are

(continued on page 94)

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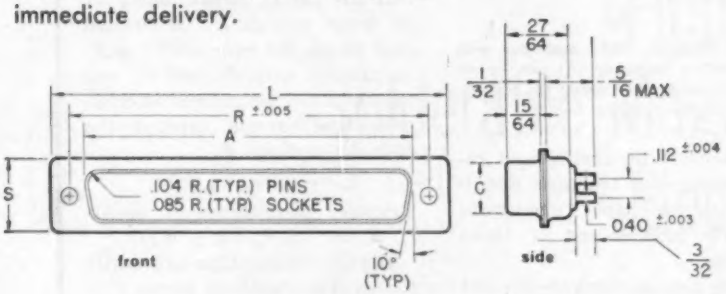

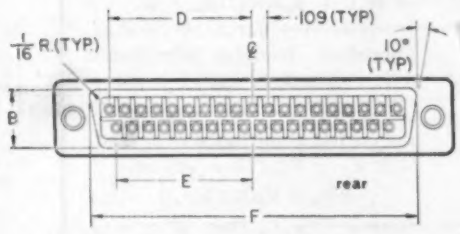

DC-37P-1

DC-37S-1

DIMENSION TAB

SIZE	A	B	C	D	E	F	L	R	S
DE- 9P-1	45/64	27/64	23/64	.216	.162	49/64	1-13/64	63/64	31/64
DE- 9S-1	41/64	27/64	5/16	.216	.162	49/64	1-13/64	63/64	31/64
DA-15P-1	1 - 1/64	27/64	23/64	.378	.324	1 - 3/32	1-17/32	1 - 5/16	31/64
DA-15S1	31/32	27/64	5/16	.378	.324	1 - 3/32	1-17/32	1 - 5/16	31/64
DB-25P-1	1 - 9/16	27/64	23/64	.652	.598	1 - 5/8	2 - 5/64	1-55/64	31/64
DB-25S-1	1-33/64	27/64	5/16	.652	.598	1 - 5/8	2 - 5/64	1-55/64	31/64
DC-37P-1	2-13/64	27/64	23/64	.978	.924	2 - 9/32	2-23/32	2 - 1/2	31/64
DC-37S-1	2-11/64	27/64	5/16	.978	.924	2 - 9/32	2-23/32	2 - 1/2	31/64
DD-50P-1	2 - 7/64	17/32	15/32	.933	.879	2-11/64	2 - 5/8	2-19/32	39/64
DD-50S-1	2 - 5/64	17/32	27/64	.933	.870	2-11/64	2 - 5/8	2-13/32	39/64

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INSULATION MATERIAL—nylon or Diallyl-phthalate

POLARIZATION—keystone shell shape

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NUMBER OF CONTACTS—9, 15, 25, 37, or 50

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Simplifying Feedback (continued from page 92)

equated, the transfer admittance with feedback is:

$$\psi_f = \psi/(1 - \gamma\psi) \qquad (1)$$

When output in Fig. 1B is open circuited, output voltage $E_{out} = \psi E_1/Y_{out}$. But $E_1 = E_{ext}$ since I_{out} = zero. Therefore, $E_{out} = \gamma E_{ext}/Y_{out}$. From Fig. 2 $E_{out} = \psi_f E_{ext}/Y_f$ with open circuit. When Eq. 1 is substituted for ψ_f, $E_{out} = \psi E_{ext}/Y_f\,(1 - \gamma\psi)$.

If open-circuit output voltages for two equivalent circuits are equated, the output admittance with feedback is

$$Y_f = Y_{out}/(1 - \gamma\psi). \qquad (2)$$

Thus, short circuit transfer admittance and output admittance of the amplifier without feedback have been divided by the factor $1 - \gamma\psi$. Usually $Y_L > Y_{out}$ and $1 + |\gamma\psi| >$ unity for $\gamma\psi$ = negative number. Therefore, $Y_L >> Y_{out}/(1 - \gamma\psi)$ and the output admittance may be neglected. The output current under these conditions equals the value of the equivalent generator of Fig. 2, $\psi_f E_{ext}$, and therefore the transfer admittance with feedback equals

$$\psi_f \cong \psi/(1-\gamma\psi) = \psi/(-\gamma\psi) = -1/\gamma.$$

Since γ can be made independent of frequency, supply-voltage variations, tube ageing and replacement; the transfer admittance and the output current are similarly independent of these variables.

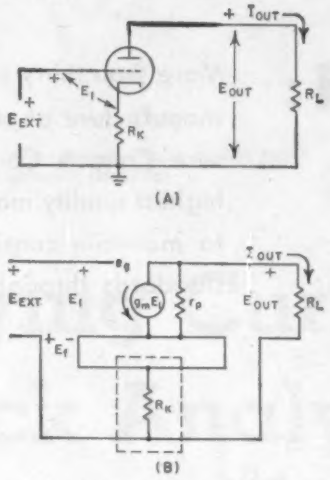

FIG. 3—Typical triode amplifier with degenerative feedback (A) can be reduced to equivalent circuit (B) for current feedback analysis

Since the equivalent current source of Fig. 2 is independent of load, its value does not have to be recalculated for different loads.

Table I presents a tabulation of current feedback parameters derived from a Norton equivalent. The standard voltage feedback relations are included for easy comparison.

TABLE I—Comparative Voltage-Current Feedback Relationship

Voltage Feedback Amplifier		Current Feedback Amplifier	
Open circuit voltage gain without feedback	K	Short circuit transfer admittance without feedback	ψ
Output impedance without feedback	Z_{out}	Output admittance without feedback	Y_{out}
Feedback voltage	βE_{out}	Feedback voltage	γI_{out}
Feedback factor	$1 - \beta K$	Feedback factor	$1 - \gamma\psi$
Open circuit voltage gain with feedback	$\frac{K}{1-\beta K}$	Short circuit transfer admittance with feedback	$\frac{\gamma}{1-\gamma\psi}$
Output impedance with feedback	$\frac{Z_{out}}{1-\beta K}$	Output admittance with feedback	$\frac{Y_{out}}{1-\gamma\psi}$
Loaded voltage gain with feedback	$\cong -\frac{1}{\beta}$	Loaded transfer admittance with feedback	$\cong -\frac{1}{\gamma}$

Typical Example

As an example of the current feedback analysis, a standard triode amplifier shown in Fig. 3A is examined. Its cathode resistor R_K is unbypassed and the load resistor R_L is considered external to the circuit for the analysis. The circuit is redrawn in Fig. 3B as a current feedback amplifier in which $Y_L = 1/R_L$, $Y_{out} = 1/(r_p + R_K)$ and $\gamma = R_K$. When E_{in} is removed, short-circuit current I_{sc} is calculated for an input voltage E_1. A shorted load places the generator $-g_m E_1$ in parallel with R_K and r_p, and the short-circuit current is effectively the current through the cathode resistor R_K,

$$I_{sc} = -g_m E_1 r_p/(r_p + R_K).$$

Transfer admittance ψ equals $I_{sc}/E_1 = -g_m r_p/(r_p + R_K)$.

Other relationships are easily found. The feedback factor $1 - \gamma\psi$ is $1 + g_m r_p R_K/(r_p + R_K) = [r_p + R_K\,(1 + g_m r_p)\,]/(r_p + R_K)$. Therefore, transfer admittance with feedback $\psi_f = \psi/(1 - \gamma\psi) =$

$$-g_m r_p/[r_p + R_K(1 + g_m r_p)]$$

and output admittance with feedback $Y_f = Y_{out}/(1 - \gamma\psi) =$

$$1/[r_p + R_K(1 + g_m r_p)].$$

Since $\mu = g_m r_p$, then $\psi_f = -\mu/[r_p + R_K\,(\mu + 1)]$ and $Y_f = 1/[r_p + R_K\,(\mu + 1)]$.

This work was supported by the Office of Naval Research.

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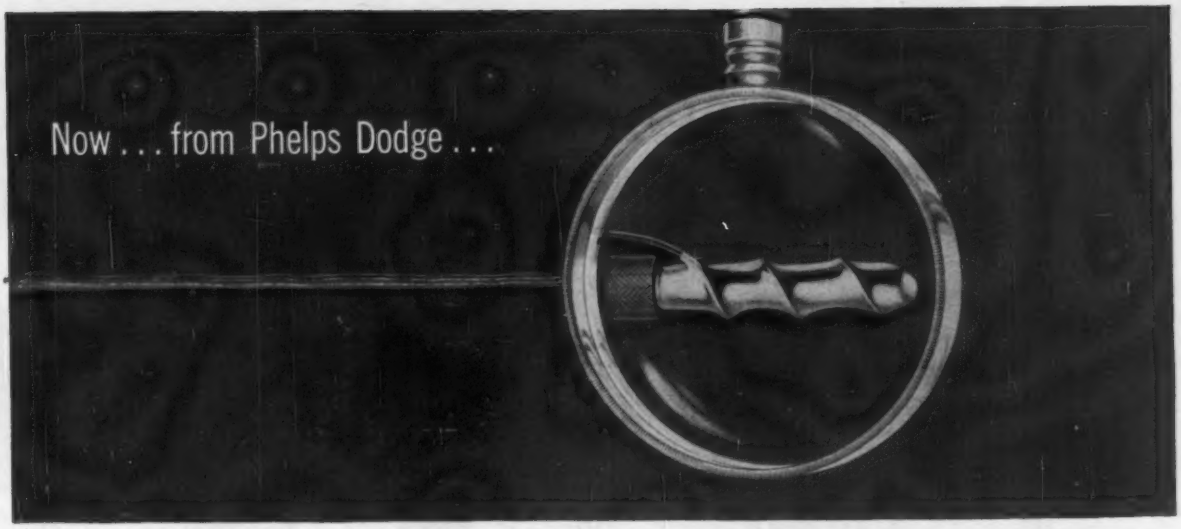

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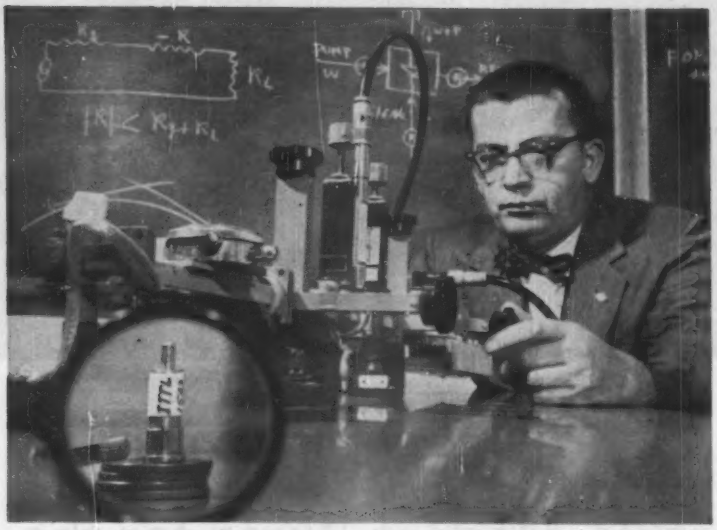

Silicon diode, shown in circle, is heart of parametric amplifier that extends 250-mile scatter link to more than 350 miles

OVER-THE-HORIZON radio links may be extended 100 miles over present 250-mile limits with a new amplifier. Still in the experimental stage, the unit was recently announced by international Telephone and Telegraph Corp.

The new device is a diode-type parametric amplifier (see Electronics, Sept. 26, 1958, pp 65-71). ITT developed a new silicon diode specifically for it.

The received 900-mc microwave signal is mixed with a 9,900-mc signal from a local oscillator. The resultant 9,000-mc output has a conversion gain of 18 to 20 db.

The 9,000-mc signal is then mixed with a 9,070-mc local-oscillator output in a standard crystal converter, producing a 70-mc i-f signal. The overall noise figure is less than one db, compared to an 8-db figure in existing systems.

The low-noise amplifier can be used to reduce power requirements, as well as extend range. If no increase in range is required, broadcast power can be reduced as much as 90 percent. Combinations of decreased power and increased distance are also possible.

Tests employing the device were recently conducted over ITT Laboratories 91-mile scatter link between Nutley, N. J., and Southampton, L. I., N. Y. Under favorable conditions, the link could be stretched from its present limit of 250 miles to more than 350 miles. Alternately, the link, which now requires 10 kw, can cut its power requirements to one kw.

Phone Calls for Broadcast

By JOSEPH ZELLE Technical Staff, WERE, Cleveland, Ohio

MODERN broadcasting often requires reporting by telephone. These short telephone reports and interviews are often recorded on magnetic tape and played back during news broadcasts or during an interruption of regularly scheduled programs.

Experience at station WERE indicates that some precautions by the station technician can add greatly to a professional-sounding result.

Federal law requires a periodic tone or beep during recorded telephone conversations. A beeper for this purpose is supplied by the local telephone company.

A schematic of the model 50B Western Electric recorder connector is shown in Fig. 1. In addition to providing a tone at levels suitable for telephone set, line and recorder, the circuit furnishes a means of interconnecting them. It also reduces the difference in speech level between line and the studio telephone set.

One half of V_1 generates rectangular pulses of 0.2 sec duration modulated at 1,400 cps. The oscillator is blocked when grid current charges capacitor C_1 through resistor R_1 to the point where the tube is cut off. The tube remains cut off for about 15 sec until C_1 has had time to discharge through resistor R_2.

The pulse is amplified in the first half of V_2 and applied through transformer T_1 to the telephone line and indirectly to the telephone set. Resistance-capacitance networks associated with T_1 and T_2 establish tone at levels suitable for the line and the set.

Speech from the line and from the set, along with the beep, are applied through T_2 to the second half of V_2. The r-c networks reduce speech level difference between line and set by about 20 db. The 1,400-cps rejection filter reduces level of the tone from −30 to −50 VU.

Output from V_2 is applied through T_3 to the recorder. Impedance of the secondary of this transformer is 20,000 ohms.

A control switch in the plate circuit of the second half of V_2 permits the recorder to be turned off during preliminary telephone conversations.

The second half of V_1 acts as a rectifier to supply B+ voltage for the circuit.

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nected across any convenient line in the station, it is usually tied across one of the extension phones in the newsroom or master control. The beeper leads may be brought out on the jack field to provide the tone for any recording.

If only a statement by the party on the other end is to be recorded, experience shows it is best to hang up the receiver in the station to avoid recording extraneous sounds. It should be hung up gently, since a loud noise can overload and break the connection. Also, the sound may alert the telephone operator who may interrupt the call.

To hold the circuit when the telephone is hung up, a low-impedance transformer (about 500 ohms) is required between the telephone line and the beeper. When interconnecting, the patch should be connected from the transformer to the telephone. Otherwise, the jack tip and hence the telephone line is momentarily grounded. This too could break the connection.

After interconnecting the equipment, the technician sets the recorder at the highest available speed to retain as much fidelity as possible.

The technician asks the person

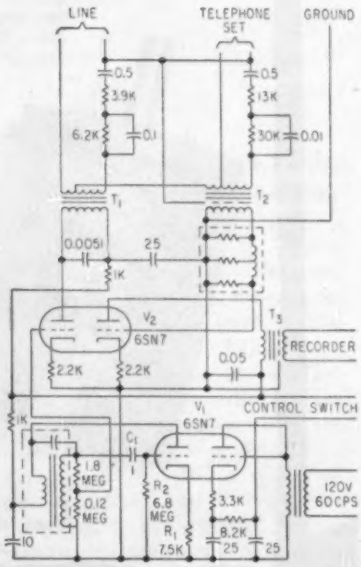
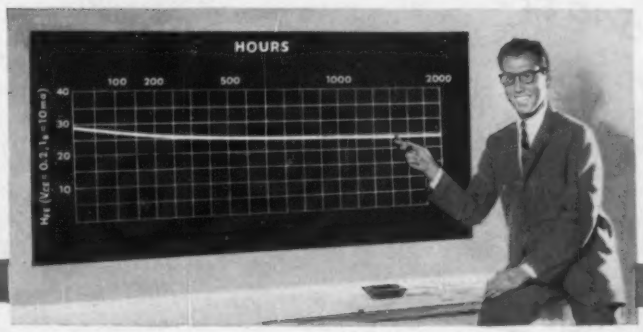


FIG. 1—Recorder connector made by Western Electric provides beeps for recording telephone conversations. Difference in level of speech from line and from studio telephone is reduced about 20 db by circuit

Now PNP SWITCHING TRANSISTORS from Sylvania

2N404
2N425
2N426
2N427
2N428



designed to give you this same reliability you've come to expect from Sylvania's full line of NPN types

HERE IS an important line of PNP switching transistors to complement Sylvania's line of NPN types. Manufacturing techniques developed for producing high-temperature stability in NPN types have been incorporated in these new PNP switching transistors. For designers this means the high reliability and stability synonymous with Sylvania NPN types, and permits circuit designs which take full advantage of the complementary aspects of NPN and PNP.

These transistors feature a new hermetically sealed inverted base TO-5 package which offers better heat dissipation to easily provide up to 150 mw at 25°C.

Electrical, mechanical, and environmental tests applied to these PNP transistors are in accordance with MIL-T-19500A.

TECHNICAL DATA

Type	V_{CB} Volts	V_{EB} Volts	V_{CE} Volts	f_{ab} min mc	h_{FE} Typical	Max. Dissipation in MW
2N404	−25	−12	−24	4.0	50	120
2N425	−30	−20	−20	2.5	30	150
2N426	−30	−20	−18	3.0	40	150
2N427	−30	−20	−15	5.0	55	150
2N428	−30	−20	−12	10.0	80	150
Temperature range −65°C to +85°C						

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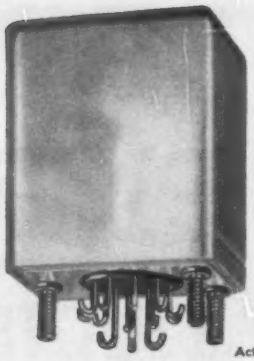

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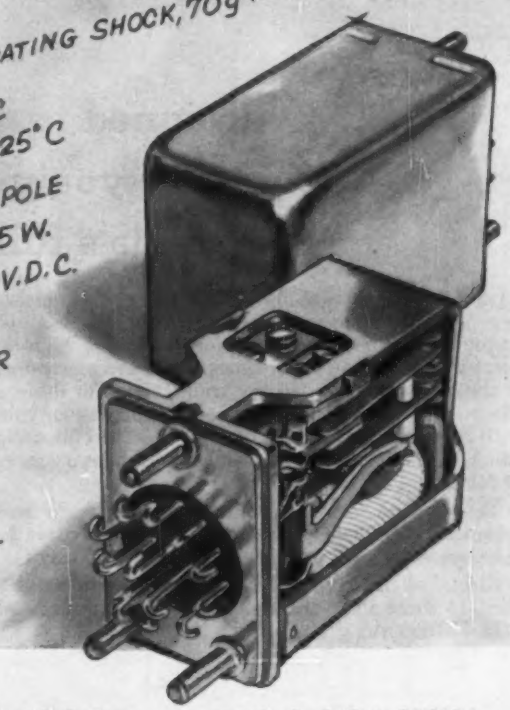
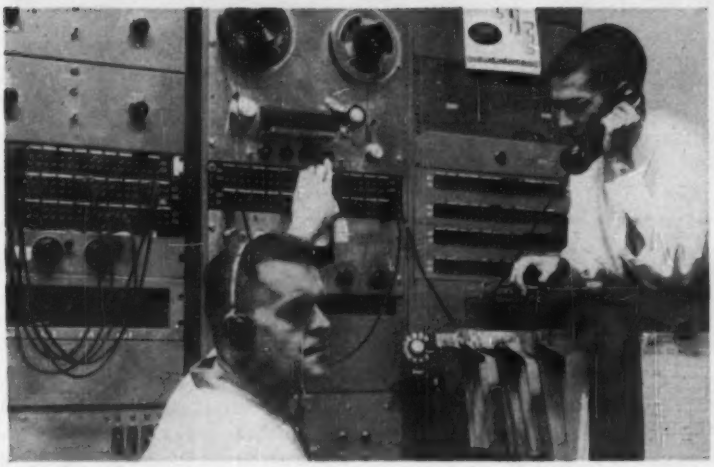
- COIL UP TO 130 V.D.C. } SENSITIVITY 0.2 W. MIN. PER POLE; MAX. COIL DISSIPATION 3.75 W.
- CONTACTS—MAX. 4 PDT 3 AMP. AT 32 V.D.C. OR 115 V.A.C. (NON-INDUCTIVE)
- SPECIAL CONTACTS AVAILABLE FOR LOW LEVEL OR DRY CIRCUIT APPLICATIONS
- APPROX. WEIGHT - 3.25 OZ.
- 30g OPERATING SHOCK, 70g NON-DESTRUCTIVE



Consult your local RBM Product Application Engineer or write for Bulletin BHSM-1.

RBM Division

ESSEX WIRE CORPORATION, LOGANSPORT, INDIANA



Newscaster-disk jockey Kent Courtright and engineer Dale Fox record telephone report in WERE control room

on the other end of the line to give a sample of his voice so that recording level can be set with the studio phone hung up. If the recording also involves the local announcer, a balance must be established between the volume of the two voices. Usually this requires that the local announcer speak farther from the mouthpiece. It may also require that the party at the other end raise his voice. For best results, the technician should ride gain.

Whenever a line is noisy, the call should be remade. On long-distance calls, where noise is more likely, the operator should be told of any noise. She will readily remake the call.

It is also advisable that the parties at both ends instruct their operators that the message is to be recorded. This will eliminate pops and clicks as the operators break in to determine if the connection is in order.

When only a statement made by the party at the other end is to be recorded, he is told to be as quiet as possible. He then counts to five or ten at a given command or at the sound of the click as the studio phone is hung up.

During the count, the technician starts the recorder and fades in the gain control. The caller makes his statement, speaking across the mouthpiece.

The closing is made as obvious as possible. Then the party at the other end remains silent until the station technician cuts in. This gives the technician time to fade down the gain control and stop the recorder.

It is good practice to play back the tape and listen for quality and level. In this way, the caller can be assured if the take was good. If not, it can be retaken.

A tape recording with objectionable noise should be cleaned by erasing if time permits. Then it should be cued up to the point where the recorded message begins. In this way, the telephone report will sound clean, smooth and professional.

Comparison Circuit Measures A-c Peaks

By G. P. GEONES

Farnsworth Electronics Co., Div. of International Telephone & Telegraph, Fort Wayne, Ind.

ACCURATE measurement of peak low-frequency a-c can be made by comparing it to a standard d-c reference. A chopper is used to make the comparison, and results are displayed on an oscilloscope.

The test setup is shown in Fig. 1. The d-c reference is adjusted to coincide with the a-c peak. At this time, the two voltages are equal.

Accuracy is somewhat dependent on visual discernment. Therefore, the presentation should be enlarged and its position adjusted to keep the pertinent part on the screen.

The basic setup has a funda-

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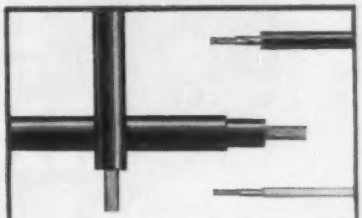

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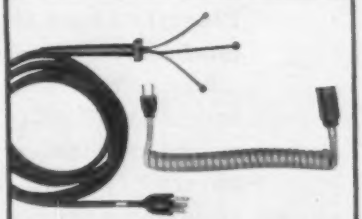

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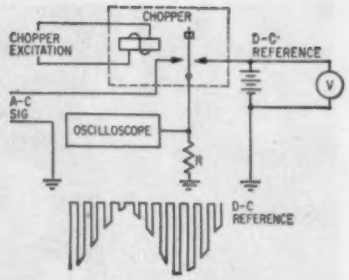


FIG. 1—Basic circuit uses chopper to compare low-level ac peaks with d-c standard. Appearance of oscilloscope presentation is shown at bottom

mental limitation for signals greater than a few volts. With the oscilloscope set for maximum sensitivity, larger signals move the pattern off the screen.

The biasing arrangement shown in Fig. 2 eliminates all but the pertinent part of the pattern. The d-c bias is maintained across resistor R by voltage from potentiometer P, which is adjusted for a few mv below the reference level.

With chopper at signal contact and peak a-c greater than bias level, D_1 again conducts. When the chopper switches to the reference contact, D_1 again conducts. As the chopper operates, voltage across R changes an amount equal to the difference between signal and reference.

This voltage appears as shown at the bottom of Fig. 2. D-c bias is removed by the a-c amplifier in the scope.

Another reference can be added so that high and low references are established. Thus two voltage limits can be shown, and the operator can readily see if the signal peak lies between the two lines. The real value of this feature is when measurement is to be made by unskilled workers on a production line.

Generation of upper and lower

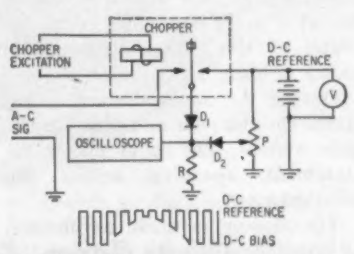
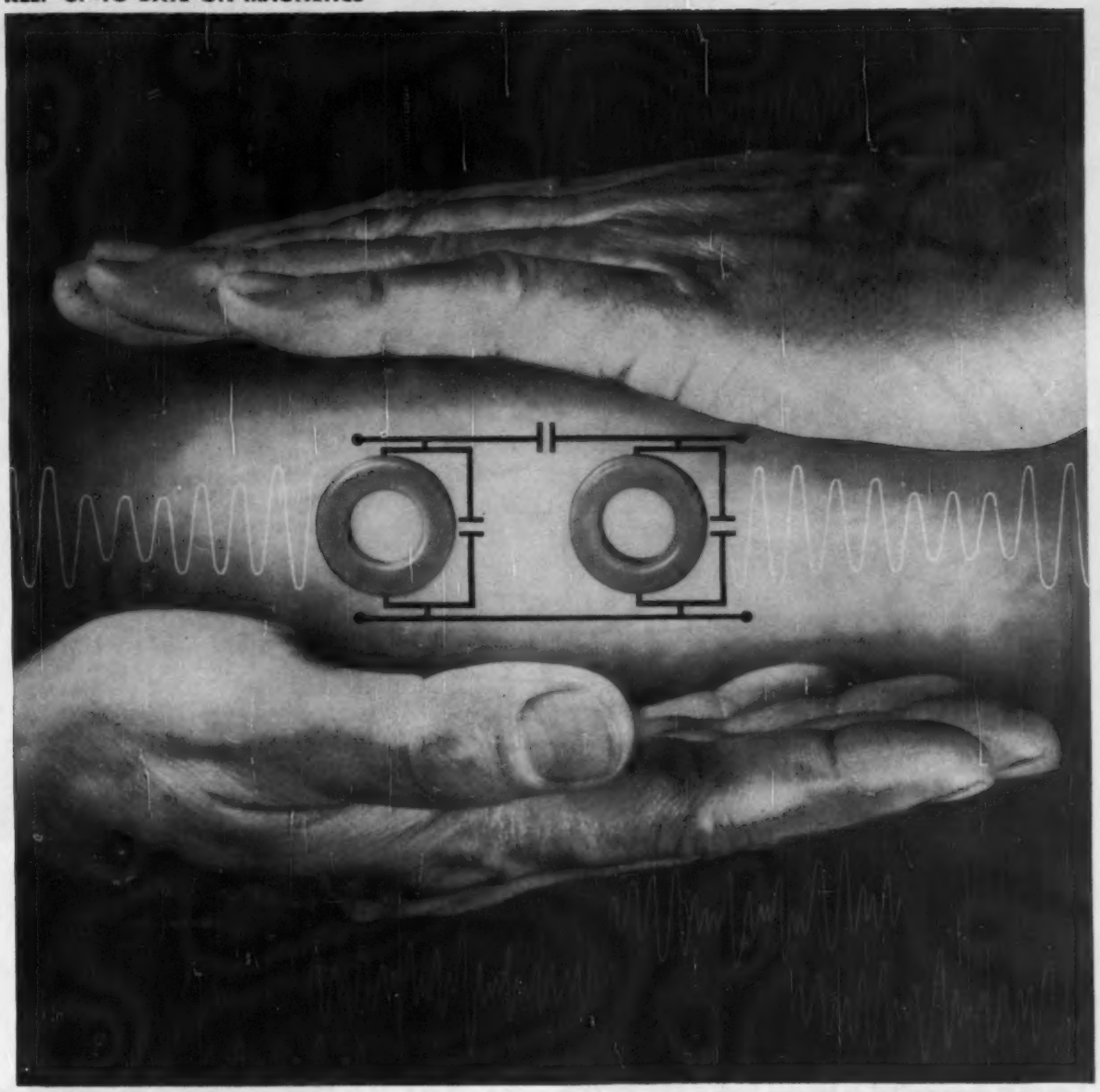


FIG. 2—Addition of biasing arrangement permits circuit to measure peaks of higher level a-c signals



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limit references is accomplished by adding a second chopper that chops the two reference voltages. Chopper output is applied to the reference contact of the first chopper. This arrangement is shown in Fig. 3.

The two choppers are driven at different frequencies. If the comparison chopper is driven at a higher frequency than the reference chopper, the pattern shown at the top of Fig. 4 will appear. The bottom of Fig. 4 shows the result of driving the comparison chopper at the lower frequency.

Care must be taken to prevent 60-cps and other interference. Standard interference reduction practices may be used with one exception. If signals from high-impedance sources are to be measured, capacitance to ground must be limited between comparison chopper reed and resistor R.

This can be demonstrated by considering the voltage across R with

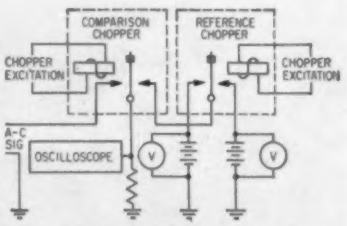

FIG. 3—Upper and lower limits can be presented by using second chopper operated at a different frequency

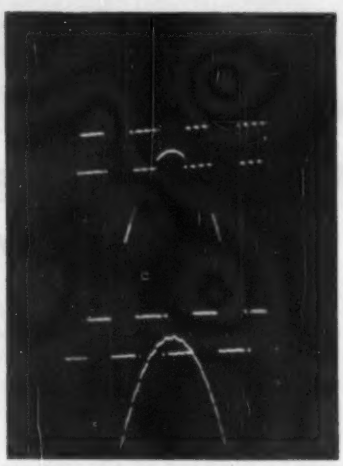

FIG. 4—A 5-cps signal at 2.5 volts is compared to upper and lower reference levels of 2.55 and 2.45 volts, respectively. Comparison chopper is driven at 400 cps in top pattern and reference chopper at 60 cps. Chopper frequencies are reversed in bottom pattern

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TEST ENGINEER touches Sperry Reflectoscope search unit to completed jet rotor forging in test for material flaws. A quartz crystal in the search unit converts high power pulse supplied by a Tung-Sol/Chatham 1258 hydrogen thyratron into ultrasonic vibrations. These traverse the forging . . . then echo back to be seen as "pips" on the scope. Irregularity of the "pip" pattern signals a material defect, thereby stopping costly trouble before it even starts.

Tung-Sol/Chatham 1258 hydrogen thyratron does "workhorse" job in Sperry Reflectoscope!

The Reflectoscope — non-destructive, pulsed-echo inspection unit made by Sperry Products, Inc., Danbury, Conn. — serves across industry. The Reflectoscope reveals hidden material flaws to help businessmen avoid unnecessary production expense and combat premature product breakdown.

Tung-Sol/Chatham's 1258 miniature hydrogen thyratron tube fills the "workhorse" spot in the Reflectoscope. Despite small size, 1.75" ht., the 1258 generates high power pulse with precise triggering . . . lack of jitter . . . overall consistent electrical stability. This over long periods of almost constant operation.

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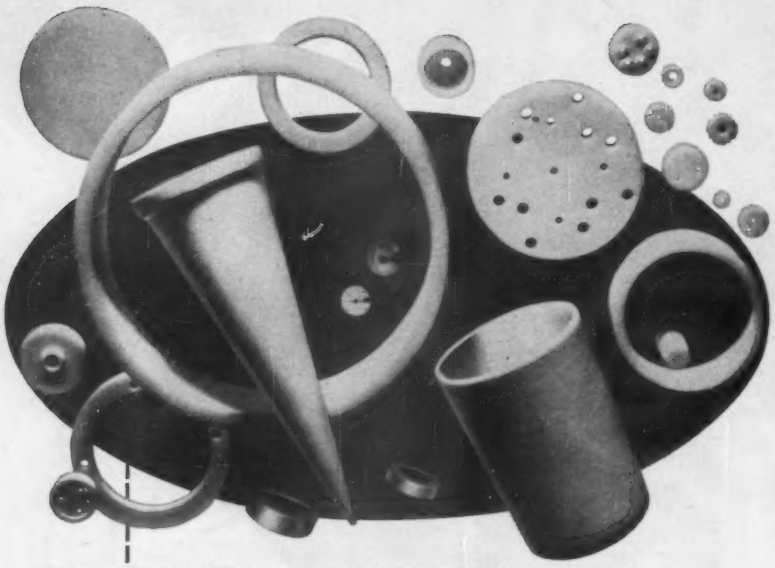

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no signal source connected. Leading edges of the pulses have a fast

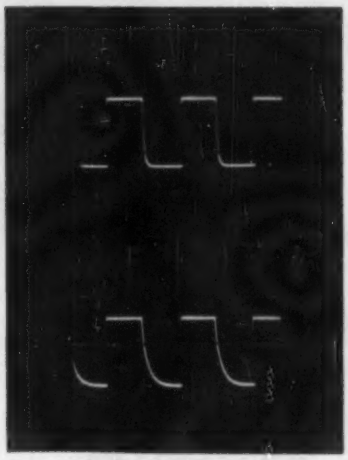

FIG. 5—Adding 200 $\mu\mu$f capacitor in parallel with wiring capacitance at bottom shows how fall time is increased

rise time because charging capacitance is quite low and charging resistance is also small. Trailing edges have a fall time considerably longer than rise time.

Longer fall time results because, although capacitance remains the same, discharging resistance is much higher. Discharge resistance consists of input resistance of the oscilloscope in parallel with R and signal source impedance. Smaller discharge resistance results in faster fall time. The effect on fall time of increasing capacitance is shown in Fig. 5.

Chopping frequency determines the space between pulses. If the chopper reed touches the signal contact before the voltage pulse has fallen to zero, the remaining part of the pulse is injected back into the signal source.

Because the bias diodes must have a high back resistance, germanium types are generally unsuitable. Silicon-junction and vacuum-tube diodes have both been used. Silicon units are more satisfactory because they do not require filament voltage. Further, at low levels the Edison effects can be troublesome with tubes. If tubes are used, filament voltage should be d-c if low-level signals are to be measured.

A problem was encountered when some oscilloscopes were connected directly across R. When measuring

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The tabulated results from Airpax Engineering Test No. 220 are shown.

HOURS *	PHASE ANGLE	DWELL TIME	
0	62°	142°	137°
1,000	62°	140°	133°
25,000	60°	136°	143°

* One year equals 8,760 hours

What kind of reliability do you require?

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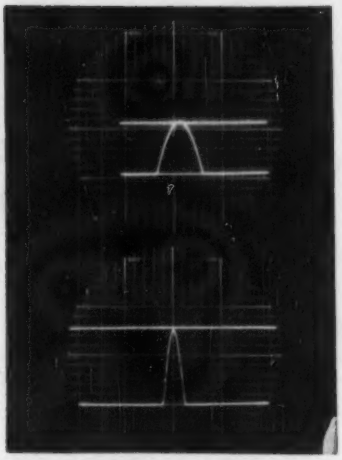

FIG. 6—Typical presentation of 5-cps signal with 0.7-volt peak is shown at top with 500 mv/in. sensitivity and at bottom with 50 mv/in. sensitivity. No bias was used for low-level signals

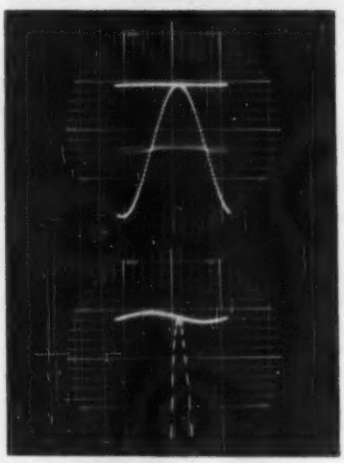

FIG. 7—Thirty-volt, 5-cps signal is shown with sensitivities of 10 volts/in. (top) and 100 mv/in. (bottom). Bias diodes were used

low-frequency signals, a dip in the reference line appeared where the signal peak touched it. This appears to be caused by the low-frequency response of the oscilloscope vertical amplifier. The effect can be avoided by using an instrument with a d-c vertical amplifier. If bias diodes are being used, it is necessary to block the d-c bias.

Wiring capacitance and a blocking capacitor on the oscilloscope d-c amplifier make it desirable to isolate the oscilloscope from R with a cathode follower. A cathode follower whose gain is accurately known can be placed between signal source and comparison chopper to increase input impedance and isolate the signal source.

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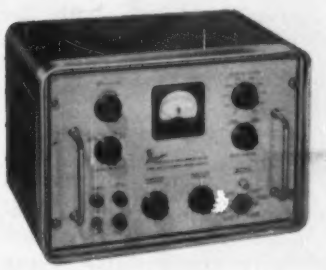


SPECIFICATIONS			
OUTPUT		**Type 812**	**Type 809**
Beam	Volts, dc	200 to 3800	250 to 600
	Current, ma	0-125	0-65
	Ripple, mv rms	5 max.	5 max.
Reflector	Volts, dc	0 to —1000	0 to —600
	Current, μa	50 max.	50 max.
	Ripple, mv rms	1 max.	10 max.
Grid	Volts, positive	0 to 150	—
	negative	0 to 300	
	Current, ma positive grid	5 max.	
	Ripple, mv rms	3 max.	
MODULATION		**Type 812**	**Type 809**
Square Wave	Frequency, cps	500 to 5000	400 to 2000
	Volts*	0 to 150 (clamped)	0 to 90
Pulse	Frequency, cps	500 to 5000	
	Volts*	0 to 150 (clamped)	—
Sawtooth	Frequency, cps	40 to 120	60, fixed
	Volts*	0 to 200	0 to 125
Sine Wave	Frequency, cps	60, fixed	—
	Volts*	0 to 200	

*volts, peak to peak

For use with all available klystrons in the low power range and for klystrons at power levels up to 5 watts, the completely new type 812 Universal Klystron Power Supply provides:

- widest application
- closest regulation
- greatest range
- minimum ripple and noise
- pulse, square wave, sawtooth and sine wave modulation.

PLUS THESE SPECIAL FEATURES:

- digital read-out for beam and reflector voltages.
- dual outputs for simultaneous operation of two klystrons.
- grid and reflector voltage clamped to CW level in square wave or pulse operation.
- front panel check calibration of grid and reflector voltages.
- multi-range overload protection for beam current.
- safety lock when transferring from + to — grid voltage.
- external triggering of internal pulse generator.

For additional details, contact your local PRD Engineering Representative or write to Technical Information Group, Dept. TIG-1.

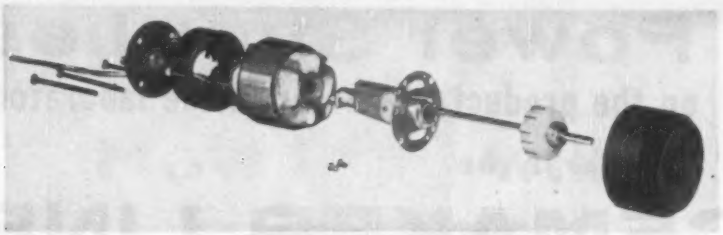
POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC.

202 Tillary Street • Brooklyn 1, N.Y.

COMPONENT DESIGN

Digital Motor for Severe Environments

By OTTO R. NEMETH, Consultant Engineer, Santa Monica, Calif.



Exploded view of digital motor shows how design eliminates screws or any other type of fastener for internal assembly of parts

APPLICATION of digital techniques in the fields of guidance for missiles, aircraft and automation has created a need for components suitable for these systems. A stepper motor, manufactured by Curtiss-Wright, West Caldwell, N. J., converts numerical digital quantities into equivalent physical motion or work.

Features of the motor include: complete static and dynamic balance, simplicity of design, minimum number of parts, capability of withstanding environmental temperatures of +165 F and insensitivity to shock and vibration.

Basic Design

Design of the motor is shown in Fig. 1. The armature is similar to a d-c motor armature except that it moves in a direction dependent upon which field coils are energized. The armature returns again to a center position upon being de-energized. This action creates a reciprocating or oscillating actuation when pulse signals are applied to either of the two sets of coils.

When receiving a pulse, the motor has the highest flux concentration at the beginning of the rotary stroke. Therefore, its highest torque is at that point, as shown in Fig. 2. This torque reduces as the armature approaches the magnetic center. This action is in contrast to that of a conventional solenoid in which minimum torque is at the beginning of the pulse and maximum torque at the end.

Four symmetrically arranged pawls actuate the motor bidirectionally and four others stop it.

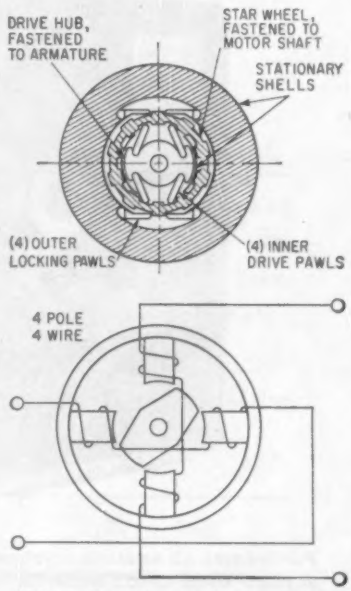


FIG. 1—Operating mechanism for digital motor (top) and schematic diagram

Pivots of all pawls are sockets. Bearings and shafts are eliminated, thereby insuring a high degree of reliability and long life.

Motion of the armature with the aid of the inside pawls actuates a cylindrical nylon starwheel which has teeth on the outside and inside circumferences. Inside teeth are motivated by the armature and transfer the force to the shaft through the relatively elastic material of the starwheel. Outside pawls have to absorb the inertia of the armature as well as the load on the shaft and therefore are much larger and sturdier than the actuating pawls.

When the motor is de-energized, all outer pawls serve to lock the starwheel and the motor shaft. Upon energizing the motor, the armature moves lifting two of the outer pawls with an attached cam to free the starwheel for motion in one direction. Because the motor shaft is fastened to the starwheel, it is also free to move in the one direction. The armature movement then carries the drive hub so as to engage two of the inner pawls against internal ribs on the starwheel. Further armature movement causes the inner pawls to drive the starwheel and motor shaft.

The two opposing inner pawls are lifted from engagement with the starwheel by the inner stationary shell under which these pawls pass. Near the end of the rotary stroke, the cam drops the outer pawls which were raised to clear a starwheel rib. These pawls then engage the succeeding rib to stop the starwheel motion and lock it in position. Because the motor shaft is fastened to the starwheel, it is also locked. De energizing the motor allows the armature to be spring-returned along with the drive hub and inner dogs.

Stator Design

The stator consists of a stack of laminations and four internal poles. Each of these poles carries a coil. The opposing coils work together in a symmetrical manner. Advantage of the laminated stator is that higher permeability materials can be used and losses are reduced. This results in higher actuating

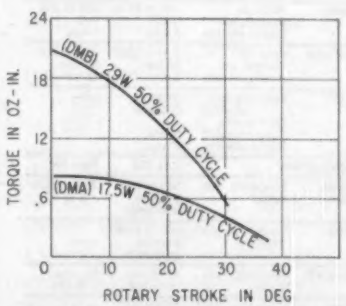


FIG. 2—Torque vs. stroke, watts and duty cycle for two models of the motor

Knee high to a grasshopper

but Fenwal's New Miniature, Hermetically Sealed THERMOSWITCH® Unit is Strong as an Ox

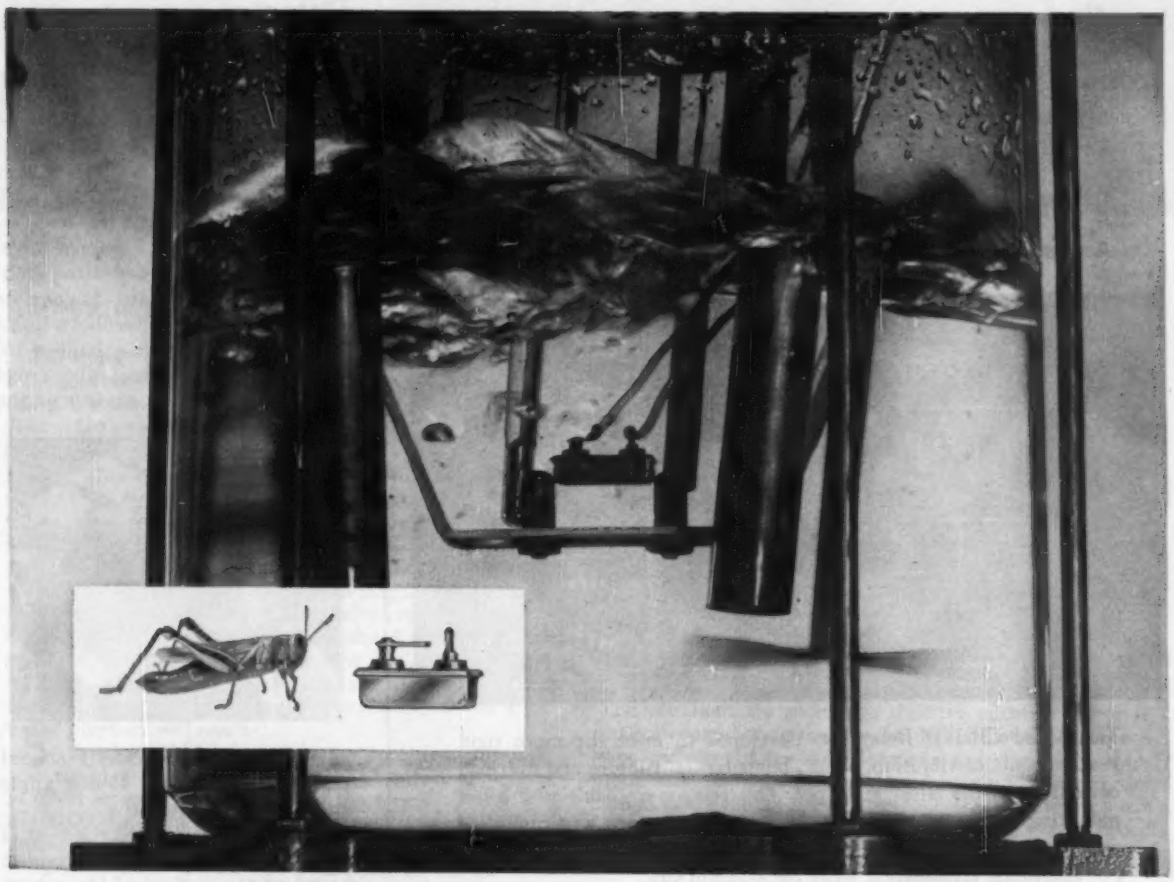
Here are acute temperature sensitivity, instant response, and the strength to withstand the most demanding conditions — all in *one unit only knee high to a grasshopper!*

It's hermetically sealed, yet field adjustable. Maintains control characteristics even with vibrations of 500 cps with 10G acceleration — *it's rugged!*

You get wide range and sensitivity, too. The new THERMOSWITCH unit controls temperatures from −20° to +200°F within 1°. Thin wall corrosion-resistant, drawn stainless steel case insures instant response to temperature changes — *you get precision control.*

You'll want to find out more about this tiny, tough, sensitive control. For more information on the new miniature hermetically sealed THERMOSWITCH unit, and other Fenwal miniaturized controls, write for our catalog or a sales engineer. Fenwal Incorporated, 2011 Pleasant Street, Ashland, Massachusetts.

New Fenwal miniature THERMOSWITCH unit being agitated in liquid bath while maintaining temperature of liquid at 140°F ±1°. THERMOSWITCH unit weighs less than ¼ oz., can withstand 10G acceleration at 500 cps vibration. Current capacity is 2.5 amps, 115 VAC, 2.0 amps, 28 VDC.

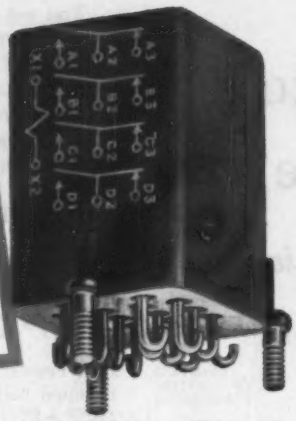


Fenwal CONTROLS TEMPERATURE . . . PRECISELY

ALLIED'S CH RELAY
Miniature 10 Amp 4PDT

Now with * Stabilized Construction

* Includes materials and processing necessary to minimize contact resistance variations and dielectric deterioration during life due to contact contamination, mechanical wear and shift of adjustments with temperature.



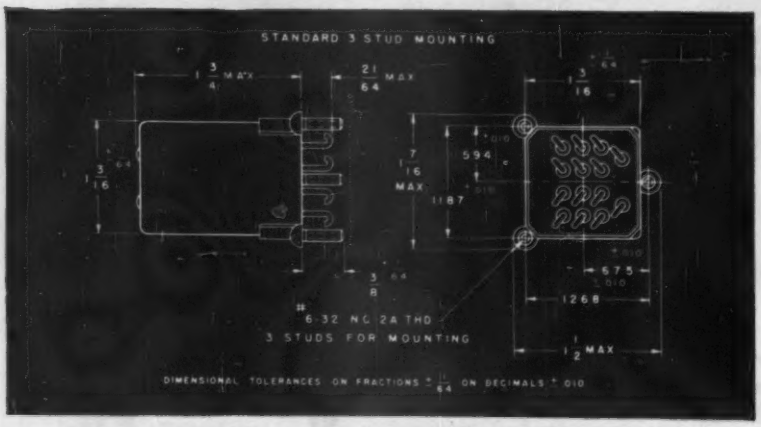
TYPE CH-12D • ACTUAL SIZE

Designed for Resistance to:

Shock—100 gravity units • **Vibration**—5 to 55 cps at 0.5 inch double amplitude 55 to 2000 cps at 30 gravity units • **Temperature**—from −65°C to +125°C

Other Specifications:

Contact Rating: 10 amperes resistive, 8 amperes inductive, at 29 volts d-c or 115 volts a-c 400 cps • **Weight:** 5.3 ounces • **Dielectric:** 1500 volts rms at sea level, 350 volts rms at 80,000 ft. • **Contact Resistance:** .01 ohm max. initial • **Contact Arrangement:** Four Pole Double Throw



The Allied CH-12D Relay was developed to meet the more rigid requirements of vibration, shock, temperature, rupture and overload conditions of the latest MIL spec. This relay is available with other mounting arrangements for special applications, such as 4 mounting studs or brackets for Allied MHY-12D type 2 stud or 2 hole mounting. For additional information write for Bulletin CH.

ALLIED CONTROL

ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N. Y.

AL180

speeds. Centering of the armature is accomplished by four sets of captive springs, heat treated for long life. Springs are used only within a small range of their capability. Fatigue or any other spring malfunction is practically eliminated.

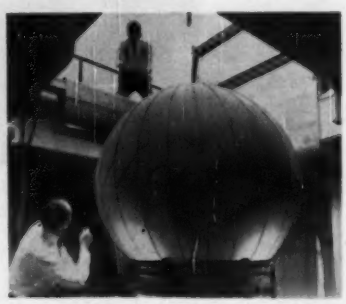
Applications

The incremental motor is suitable for many applications. It has been used to generate the intermittent movement for pulsed cameras. The motor can be programmed by tape to actuate many types of automatic equipment. Other applications include flight control in missiles, an actuator for automatic pilots and for automatic machine-tool feeds. The motor is presently available in two sizes.

Antenna, Transducer, Detector Announced

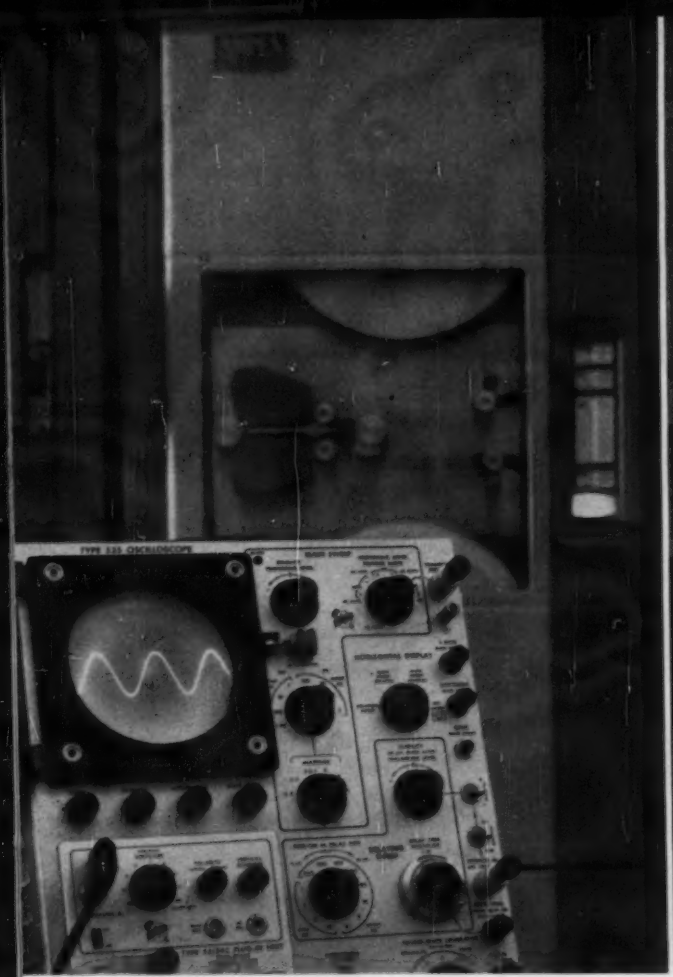
SEVERAL new components announced by Westinghouse Research Laboratories cover varied fields of application.

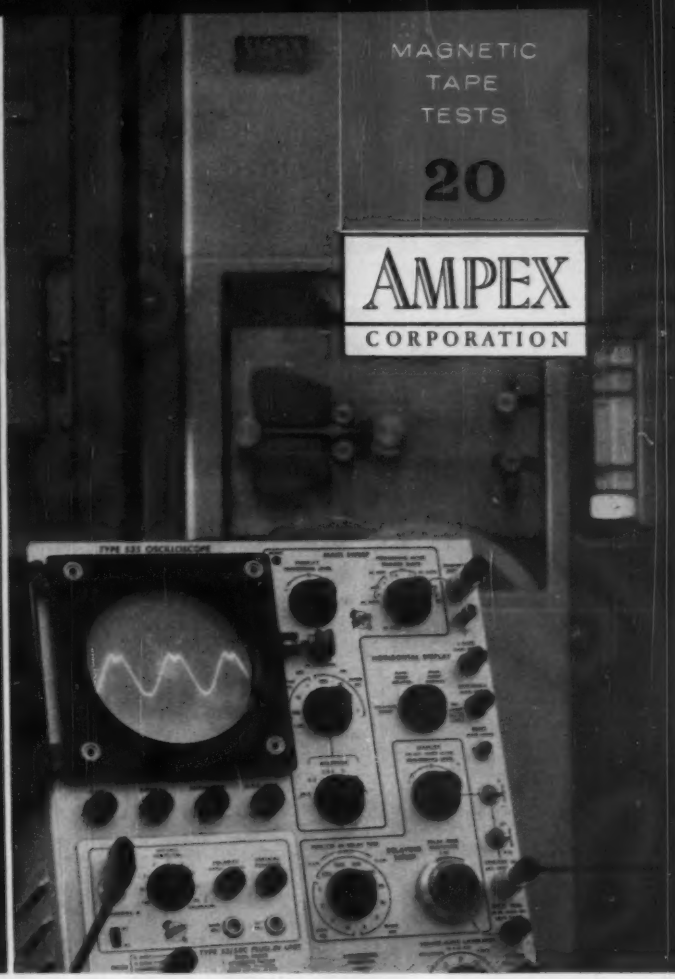
One of the new developments is a novel type of radar antenna with possible application in low-frequency, long-range defense systems. The antenna, called the Helisphere, does not rotate. It consists of a sphere with the feedhorn in its center. The sphere is a balloon inflated at a pressure of about one in. of water. On the surface of the



balloon is a grid of closely spaced conductors making a 45-deg angle with the perpendicular.

The feedhorn is polarized at a 45-deg angle. The conductors are wound on the surface of the sphere so that the microwave beam from the horn encounters a grid of conductors parallel to the E plane of propagation in the forward direc-





MAGNETIC TAPE TESTS

20

AMPEX CORPORATION

How choice of tape can affect recording quality

AMPEX INSTRUMENTATION TAPE shows up important differences in FM-carrier recording

The signals you see in the scope result from a very real difference between two magnetic tapes. On FM-carrier data, one is a shining success and the other is a dismal failure. Herein lies a trap for the unwary because both are currently sold for instrumentation use.

Say "FM-carrier" to a magnetic-recording expert and chances are two to one the first thing that pops to his mind is *low frequencies*. No other tape technique can match FM-carrier's ability to cover frequencies from a high of 10,000 or 20,000 cycles right down to a low of DC.

Yet the most important quality in a magnetic tape for use on FM-carrier recording is *high-frequency* response. Contradictory? Not a bit! Since it is a modulated carrier that gets recorded, the tape itself sees nothing but relatively high-frequency signals whether the data are high frequency or low. Eliminate any high-frequency components and a distorted playback will result.

It was a lack of high-frequency response that caused the poor signal on the scope to the right. The surface of this tape in effect separates the oxide from the recorder's heads by 5/100,000ths of an inch. This is sufficient to cause the distorting effect you see.

Performance of Ampex Instrumentation Tape is shown on the scope to the left. Its characteristics are exactly the opposite. Head-to-tape contact is exceptionally good because the exclusive Ferrosheen process has eliminated even the microscopic lifting of the tape normally caused by surface roughness. Also, Ampex Instrumentation Tape has magnetic properties that cause it to resist high-frequency demagnetization.

Both tapes were recorded on the same machine at 60 in/sec. Input signal was 500 cycles at 1 volt. Scopes show the playback of each.

A 4-DECIBEL BONUS

Even in a sampling of various makes of tapes having sufficient high-frequency response, our laboratory found as much as four decibels spread in FM-carrier signal-to-noise ratio. Cause of this difference is amplitude modulation. This is the change of reproduced-signal amplitude caused by variations in tape-coating thickness and by momentary loss of head-to-tape contact.

The FM-carrier signal is recorded on the tape at near-saturation level. On playback this theoretically should give constant-amplitude peaks and precise crossovers. It doesn't. The variations are enough to shift the effective crossover points, contradicting the common belief that the recorder's tape transport is the only determining factor in signal-to-noise ratio on FM-carrier. In our laboratory, one recorder tested all the tapes—proving the four-decibel difference and another advantage of Ampex's super-smooth Ferrosheened surface!

Though highly effective for FM-carrier data, Ampex Instrumentation Tape does not favor this one technique to the detriment of others. For example, the Ferrosheened surface is an advantage to all. Direct recording, in particular, was discussed earlier in this series. For additional technical data on magnetic tape, write Dept. E-20.

AMPEX INSTRUMENTATION DIVISION • 860 CHARTER STREET • REDWOOD CITY, CALIFORNIA

Phone your Ampex data specialist for personal attention to your tape needs. Offices serve U. S. A. and Canada. Engineering representatives cover the free world.

electronics READER SERVICE CARDS

. . . have increased the flow of product and service information between buyers and sellers.

. . . have helped increase manufacturers' sales.

Reader Service Cards have been provided to get quick and easy information on products.

Avail yourself of this Service to get all the information you need.

Manufacturers are cooperating wholeheartedly with the Service to supply information promptly.

ABC electronics ABP
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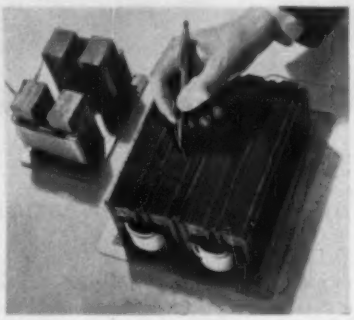
330 WEST 42nd ST. NEW YORK 36, N. Y.

tion. The energy is reflected as in the case of a conventional paraboloidal reflection. In the back direction, the conducting grid is at 90 deg to the plane and the energy passes out of the antenna.

A demonstration model of the antenna was 5.5 ft in diam and provided a beam of three-cm energy that was one deg, 20 min wide in azimuth at the half-power points. A full-scale model could be constructed using the principle of the Paraballoon now used for radar antenna shelters in some systems. For a 60-cm radar system, the present model could be scaled up to 100 ft in diam.

Magnetostrictive Transducer

Another development is an ultrasonic magnetostrictive transducer made up of thin nickel laminations spaced uniformly at critical points over the surface of a plane. The technique is claimed to double tranducer efficiency and cut costs



by one-quarter. Less material is used than with conventional units, cooling is easier, and lighter plates and housings are adequate. Up to 50 w per sq. in. of power can be delivered by the transducer in the range from 15 to 40 kc.

Possible applications include ultrasonic dishwashing, silver-plating of bus bars (plating time cut from 30 to 2.5 min and plating baths from 12 to 3) cleaning printed-circuit boards and salvaging contaminated atomic materials.

Infrared Detector

A third component is a new infrared detector that can respond to less than one-twentieth of a billionth of a watt of infrared radiation.

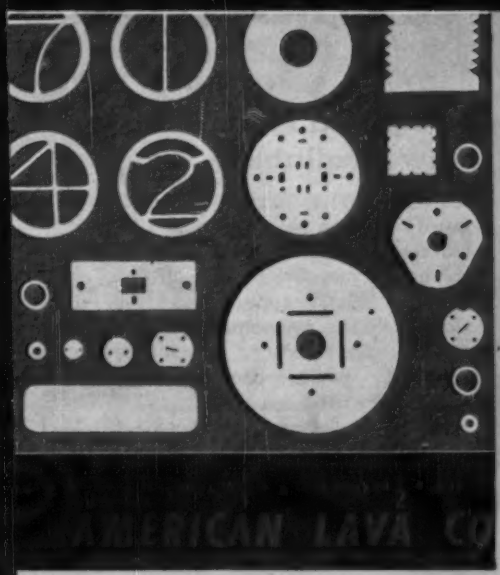
The new detector is made of germanium doped with gold. The

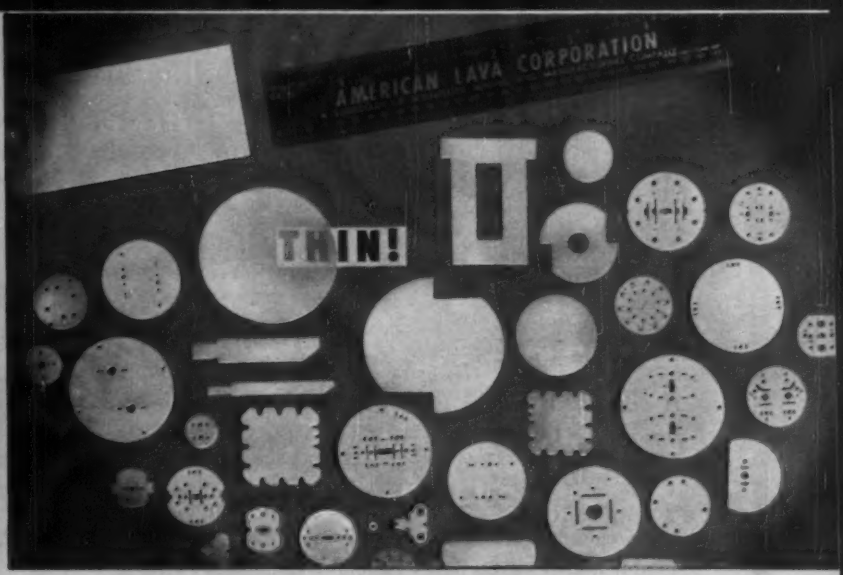
CIRCLE 80 READERS SERVICE CARD→

NEW AlSiMag® THIN CERAMICS!

will these alumina ceramics give you

SMALLER, LIGHTER, MORE RUGGED UNITS?





Miniature AlSiMag Alumina Ceramics—some as thin as 0.005"—are being used in electron tubes, microwave windows, transistor platforms . . . as insulators in hearings aids . . . in digital counter tubes, radio crystal cages . . . in high temperature transformers, relays, fuses, micro-modules . . . high temperature amplifiers . . . and other high temperature devices including high temperature printed circuitry . . . as well as various mechanical applications.

The relatively high strength of these thin ceramics and their superior performance in high temperature, high frequency applications may help you answer the demands for smaller, lighter, more rugged units. This strength also sharply reduces damage from fatigue failure, heat deterioration, shock and vibration, and makes new automatic assembly operations practical.

Since these thin ceramics were pioneered by American Lava several years ago, demand has increased rapidly and steadily. Spurred by constantly increasing requirements, our production facilities are now capable of shipping in volume and at practical prices, small intricate shapes that were considered impossible as recently as 1955.

Free bulletin and typical samples of thin AlSiMag Ceramics sent on request

A Subsidiary of Minnesota Mining and Manufacturing Company

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENN.
57TH YEAR OF CERAMIC LEADERSHIP

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Dynamic Analysis of Frequency Response

A combined sweep generator and c.r.o. suitable for v.h.f., i.f., and v.f. response analysis

FEATURES

• Sweep width variable up to 10 Mc • Crystal controlled fixed-frequency marker pips • Calibrated continuously variable frequency marker • High output • Sensitive Y amplifier • Output level controlled by piston attenuator

APPLICATIONS:
Alignment and response measurement on television and f.m. v.h.f. receivers; v.s.w.r. of feeder lines; matching feeders to antennas; direct tests on i.f. and r.f. transformers; use as a general purpose oscilloscope.

ABRIDGED SPECIFICATION
Frequency Range: R.F. 50-75 Mc, 75-115 Mc, 150-216 Mc; I.F. 10-45 Mc; V.F. 5 kc-10 Mc.
Output Range: 100 μV-100 mV.
Sweep Width: variable from 500 kc to 10 Mc.
Calibration: continuously variable marker oscillator provides pip corresponding to known frequency, 3-frequency crystal oscillator generates pips at intervals of 5.0, 1.0 and 0.5 Mc.
Time Base: 12 to 50 cps for sweep, 12 cps to 10 kc for general purpose.
TUBES: 5Z4G, 12AT7, 12AU7, 12AX7, 6C4, 6AK5, 6AK6.

MARCONI INSTRUMENTS

**111 Cedar Lane
Englewood
New Jersey**

CANADA: CANADIAN MARCONI CO · 6035 COTE DE LIESSE · MONTREAL 9
ENGLAND: MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE

TC 125

photoconducting material is sensitive to infrared radiation up to a wavelength of 10 microns and has fast response. Its time constant is about two-tenths of a millionth of a second.

Because sensitivity and frequency response of a photoconductive infrared detector are increased at low temperatures, the new detector is cooled to 320 deg below zero Fahrenheit with liquid nitrogen in a special container.

Integrated Magnistor Now Available

HIGH-RETENTIVE ferrite is combined with a high-permeability, low-retentive ferrite in Potter Instruments new MPT-1 Magnistor. Typical digital applications possible with the new component are sorting and collation, coincidence detection, parity checking and digital servo follow-up.

The unit is an eight-terminal device. The SET input terminals provide access to the high-retentive ferrite for data storage. The associated RESET winding, when actuated, dissipates the stored mag-

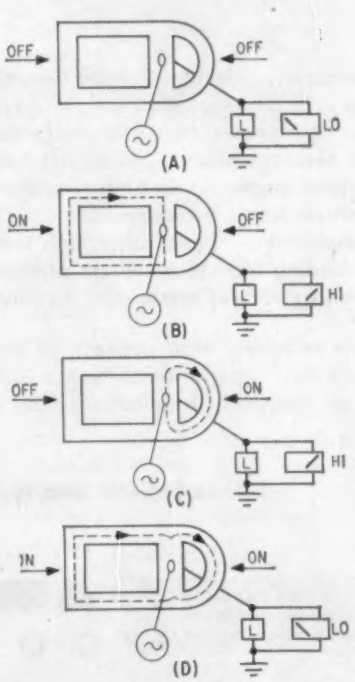


FIG. 1—Four logical states of the integrated Magnistor

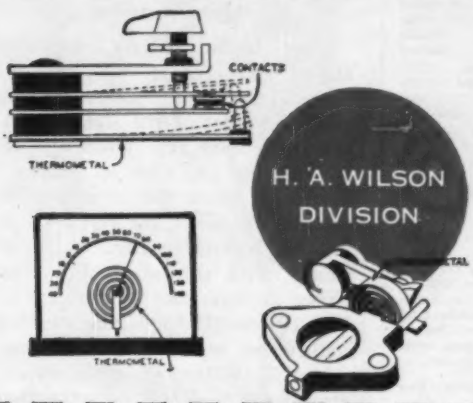
FOR A MIRROR BRIGHT FINISH

"SILVA-BRITE" SILVER PLATING PROCESS . . . Provides hard, bright, highly-ductile finish in stable deposits from flash to heavy. Water-clear solution enables plater to watch process; parts falling into tank may be recovered without contamination. Uniformly good results with current densities from 10 to 40 amperes per square foot; operation and control are non-critical, economical. Filtration through activated carbon removes organic contaminants; no purification downtime. Excellent throwing power, less tendency toward bath decomposition or fumes. Write for technical bulletin.

American Platinum & Silver Division, 231 New Jersey Railroad Avenue, Newark 5, N. J.

CIRCLE 100 READERS SERVICE CARD

FOR CONTROLLING TEMPERATURE



THERMOMETAL® . . . for use in electrical appliances, thermal cutouts, heating controls . . . in any application involving the indication and accurate control of temperatures, electrical currents, voltages, etc. Supplied in strip form, rolled and slit to close tolerances and tempered to meet specifications. Also supplied as elements and sub-assemblies, with or without contacts attached, fabricated in accordance with specifications.

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DEOXO® PURIFIER . . . provides low-cost catalytic purification of hydrogen and other gases to the extent of less than one part oxygen per million. Requires no operating expense, no maintenance, no reactivation, no auxiliary heating, no water cooler. DEOXO® DUAL PURIDRYER . . . combines continuously-operating, dual tower, automatically-run drying unit with the features of Deoxo Purifier—catalytically produces pure, dry hydrogen, so pure it contains less than one part oxygen per million, so dry that it has a dew point of better than —100° F.

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BIRD

"Termaline"
DIRECT READING
RF LOAD-WATTMETERS
SERIES 6100

MODEL 612
Models 61 and 611 are identical in appearance

These popular direct reading instruments measure and absorb power in 50 ohm coaxial line systems through the range of 30 to 500 mc.

They are portable and extremely useful for field or laboratory testing . . . checking installation of transmitters . . . trouble shooting . . . routine maintenance . . . production and acceptance tests . . . transmitter tune-ups . . . measuring losses in transmission lines . . . testing coaxial line insertion devices such as, connectors, switches, relays, filters, tuning stubs, patch cords and the like . . . accurately terminating 50 ohm coaxial lines, and . . . monitoring modulation by connecting phone, amplifier or audio voltmeter to the DC meter circuit.

Power scales for Model 61 Special are made to meet your requirements.

WRITE FOR BULLETIN TW606

SPECIFICATIONS

RF INPUT IMPEDANCE: 50 ohm nominal.

VSWR: Standard specification 1.1 to 1 maximum over operating range.

ACCURACY: 5% of full scale.

INTERNAL COOLANT: Oil.

POWER RANGE: Model 611—0-15, 0-60 watts full scale. Model 612—0-20, 0-80 watts full scale.

INPUT CONNECTOR: Female "N".

EXTERNAL COOLING METHOD: Air Convection.

RADIATOR STRUCTURE: All Aluminum.

FINISH: Bird standard gray baked enamel.

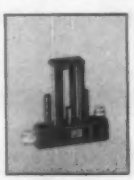
WEIGHT: 7 pounds.

OPERATING POSITION: Horizontal.

OTHER BIRD PRODUCTS

"Thruline" Directional RF Wattmeters

"Termaline" RF Load Resistor


Coaxial RF Filters

Coaxial RF Switches

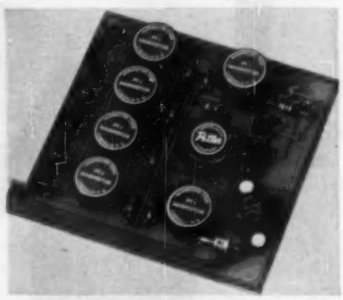
BIRD ELECTRONIC CORP.
EXpress 1-3535
1800 E. 38 St., Cleveland 14, Ohio
Western Representatives: VAN GROOS COMPANY, Woodland Hills, Calif.

netism. The alternate states of magnetism resulting are evidenced by a two-state change of inductance of an r-f signal winding. This action is indicated by an r-f signal externally supplied.

The INT (interrogate) winding is associated with the high-permeability ferrite. It effects an identical change of the r-f signal winding inductance. But with the lack of magnetic retentivity, the response is proportional to the applications of current to the INT winding. When both magnetic circuits are considered in combination, effects of each with respect to the other is complementary.

Magnetic States

The four possible magnetic states that may exist within the Magnistor and the corresponding relative values of the signal winding inductance are shown in Fig. 1. For Fig. 1A, with no magnetic flux from either the permanent or transient sections, the signal winding will exhibit a high inductive value. With saturating flux from either of these two sections, as in Fig. 1B and 1C, the signal winding inductance will be reduced considerably. With both sections energized, as in Fig. 1D, the saturating flux through the signal winding core is removed by the proper polarization and coercive effect of the energized interrogate winding.



Alpha-numeric character module for storage, comparison, coincidence detection and solenoid drive

An r-f signal source, the Q-1Y, made to be used with Magnistors, is a complete oscillator package fully encapsulated and designed for printed-circuit applications. A d-c input of −20 v will produce an output signal of about 2 v rms to accommodate at least 10 Magnistors.

STOP the EYELET HUNT

Simplify design
Speed production
$ave money

You can save many expensive engineering hours because designers no longer need to plow through thousands of eyelet specifications. Over 20 years' experience has shown that a very high percentage of all eyelet work can be done with the 7 United Standard diameters.

Use UNITED Standardized Sizes

RACEWAYS ALSO STANDARDIZED
DIAMETER OF BARREL
•The diameter given indicates the size hole for the eyelet
These eyelet numbers are descriptive. For example
In SE-611, the SE means Standardized Eyelet.
The first number (6) indicates Barrel Diameter (6/32").
the number or numbers which follow indicate Barrel Length (11/32").

Only 7 sets of tools for all 65 sizes
All eyelets in each column set by same tools.

Only *SEVEN* sets of tools needed for all 65 sizes! This means that tooling is reduced as much as 90%. With United's closely co-ordinated system of Standardized Eyelets and Eyeleting machines, eyelet grip can be increased as much as 1000% (for instance, from .093" to .437") without a single change in drill, punch, or setting tool. Result: greatly reduced installed costs and true fastener economy.

Purchasing problems are eliminated. United Standardized Eyelets are carried in stock at key points: United's Shelton Eyelet Division plant near New York and branch offices in Chicago and Los Angeles. Low eyelet costs for you are ensured by United's constant high volume production on a relatively small number of sizes.

Inventory is greatly simplified. Fewer sizes do more jobs. Actual experience of thousands of users for over two decades has shown that United Standardized Eyelets and co-ordinated Eyeleting machines can reduce the number of eyelet sizes carried in stock an average of 66⅔%.

Precision made in standard increments of 1/32" in both barrel O.D. and length, each one of the 65 United Standardized Eyelet sizes has a standard relationship in dimension and proportion to every other eyelet in the series. They are designed to save you money. Start to-day to enjoy the advantages of United's Standardized Eyelets. Write or call us for complete information.

New Eyelet Catalog Complete specifications of all phases of United's co-ordinated system of eyelets, eyeleting machines, setting tools. Also includes data on special eyelets and metal stampings.

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BOSTON 7, MASSACHUSETTS

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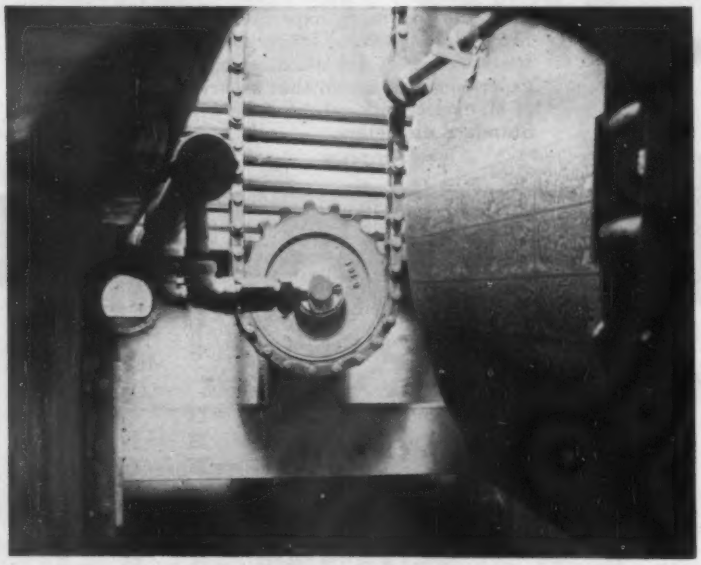
Degrease Vapor Develops Printed Wiring

By R. A. GESHNER and H. R. HODGE, JR., Stromberg Carlson Division, General Dynamics Corp., Rochester, N. Y.



View through porthole of developing machine, showing condensation coils, mist spray nozzles and multiple sheet of printed wiring in development position

VAPOR DEVELOPMENT of photo sensitive resist, during the manufacture of printed wiring cards (Fig. 1), is a problem of considerable interest. When the thin coating of photo resist is exposed to actinic light, it is rapidly polymerized, and becomes moderately impervious to solvent attack. Unexposed resist is readily dissolved.

In addition, at least one type of photo resist withstands temperatures over 300 F. Thus, photo resist properties allow development of the exposed coating by trichlorethylene vapor degreasing techniques.

Early tests proved the feasibility of the process and in 1955 a single-end load-and-unload, vapor spray, vapor type G. S. Blakeslee Co. degreaser was purchased to support high volume printed circuit production. Tests showed that proper adjustment of 2 major variables of the machine's operation would ensure 100 percent output. The variables are: time of work immersion in the trichlorethylene vapors and liquid solvent spray of the work in the vapor.

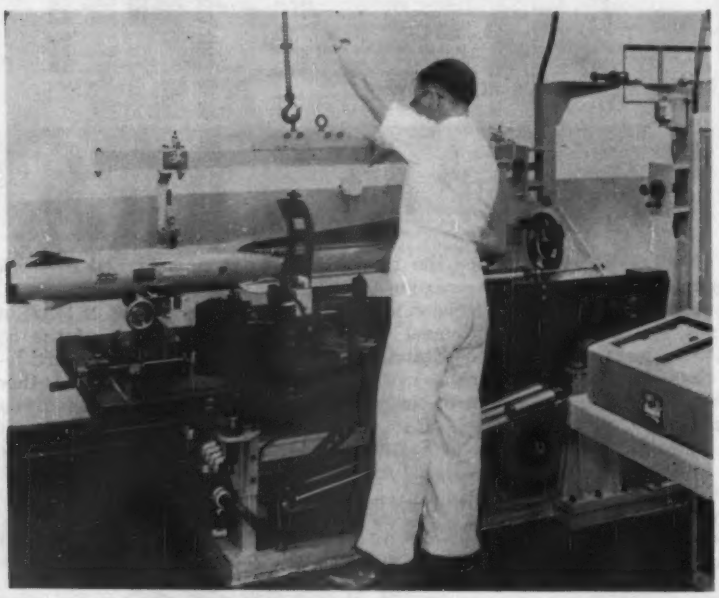
Immersion time is easily controlled by setting machine conveyor speed. One minute and 50 seconds immersion is optimum. This is dependent, however, on spray technique and control.

Spray Speeds Process

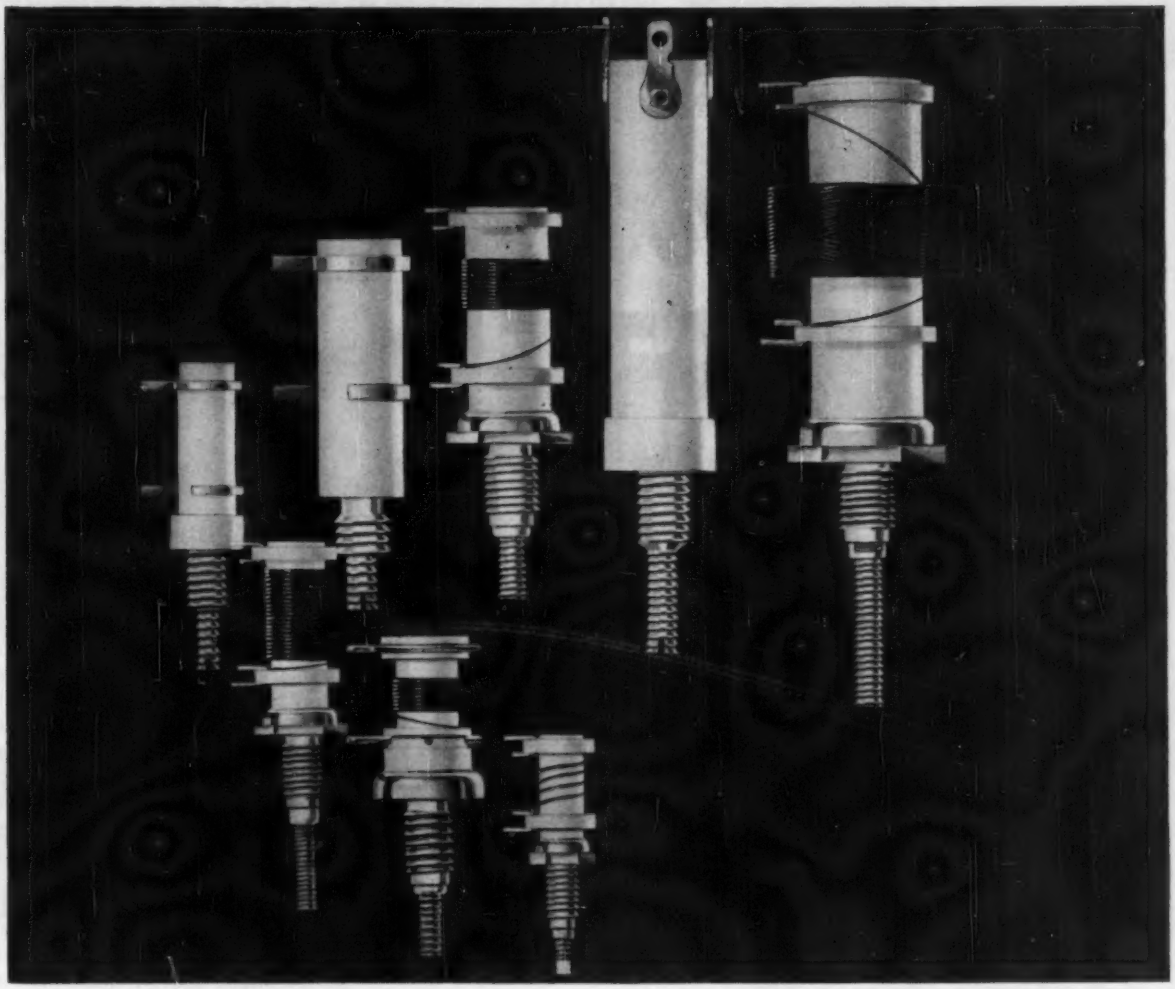
The liquid solvent spray flushes off the unexposed, vapor-softened resist, leaving bare conductor to be etched. Vapor development without the spray takes 3 to 5 times as long and also causes streaks or runs of resist which sometimes resulted in difficulty in etching.

A spray nozzle manifold was therefore incorporated in the machine, as shown in Fig. 2. The nozzles are Spraying System Co. nozzle T6510. At fluid pressure of 5 psi, a flat atomized spray is produced with a spray angle of 30 degrees and delivery of 0.35 gallons a minute of solvent by each nozzle. This spray is applied to the work

Missiles Tested Automatically



Falcon missiles are tested for balance on this aircraft missile weight and balancing system built by Baldwin-Lima-Hamilton for Hughes Aircraft. Arrangement of B-L-H SR-4 sensing elements and load cell in the stand measures missile's weight, finds longitudinal and lateral centers of gravity and thrust alignment. X-Y plotter and printer mark measurements on chart. Hoist moves missile directly from production line to platform. Missile is lined up by insertion of pin in tooling hole



Standard Coil Forms with screw thread mounting are LS-3, LS-4, LS-5, LS-6, LS-7, LS-8, LS-M, and LS-T. The LS-5, -6, -7, -8, and -T are available with Perma-Torq®.

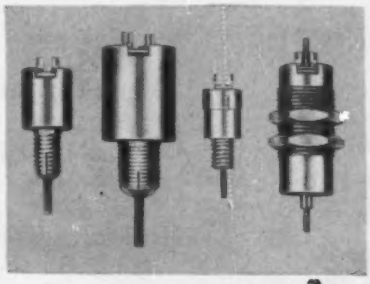
Coil up with this Form!

There's a guaranteed CAMBION® coil form for every coil winding problem! The CAMBION stock of standard coil forms provides a reliable source for any quantity you need, and CAMBION custom components carry the *same* guaranteed performance.

Standard CAMBION coil forms are compactly designed and carefully manufactured to withstand the most severe working conditions. They mount with a screw thread, are available with a variety of locking devices, including unique Perma-Torq® which allows locking of tuning cores while still tunable.

CAMBION printed circuit coil forms are ideal for use in printed and transistorized circuits. Time-saving coil leads can be soldered to circuitry when the component is mounted. Available in a wide range of sizes and materials—and you can rely on their performance.

Get guaranteed performance from every single coil by ordering CAMBION coils. Write Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Massachusetts. West Coast stocks handled by E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles 16, California. In Canada: Cambridge Thermionic of Canada Limited, Montreal, P. Q. CAMBION products now available from leading distributors throughout the U. S. and Canada.



CAMBION shielded coil forms are specially designed to give top performance in "tight spots." The LS-9 is 7/16" in diameter, 1/2" high. LS-10 is 1/2" in diameter, 1 1/16" high. LS-11 is 5/16" x 17/22". The LS-14 is double ended, 1/2" O.D., and 1 1/4" overall. All are highly shock resistant.

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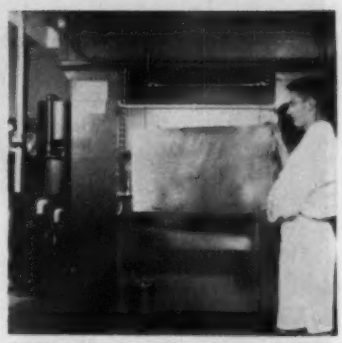

Loading vapor developing machine. Distillation unit is at left

during the last 30 seconds of vapor immersion with the spray action within the vapor head.

The machine is easy to operate and simple to maintain. Setup, ½ hour before use, involves turning on steam, cooling water and exhaust ventilator. Steam heats the trichlorethylene to 188 F to produce the developing vapor. Cold water is circulated in both the vapor developing condensate jacket and the still condensate jacket.

During operation, the work is hand loaded and unloaded, while the liquid spray mechanism is actuated and automatically controlled by work flow through the machine. Shutdown consists of turning off power. To ease maintenance and insure vapor purity, a distillation unit was installed.

The process's only disadvantage is initial capital outlay. Advantages

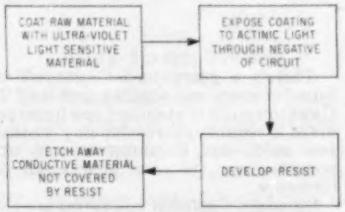
COAT RAW MATERIAL WITH ULTRA-VIOLET LIGHT SENSITIVE MATERIAL
EXPOSE COATING TO ACTINIC LIGHT THROUGH NEGATIVE OF CIRCUIT
ETCH AWAY CONDUCTIVE MATERIAL NOT COVERED BY RESIST
DEVELOP RESIST

Fig. 1—Basic flow chart of photo resist printed wiring technique

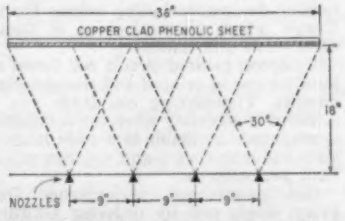

Fig. 2—Nozzle arrangement used in vapor developing operation

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CIRCLE 87 READERS SERVICE CARD→

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Maximum Values for AUTOMATIC Military Type Silicon Rectifiers designed to meet the new JAN MIL-E-1 Specification

Type No.	Peak Reverse Voltage (VDC)	DC Output Current @ 25° C. Ambient (MA)	DC Output Current @ 150° C. Ambient (MA)	Maximum Reverse Current* (MA)	Mounting	MIL-E-1 Technical Spec. Sheet No.
JAN 1N538	200	750	250	0.350	Axial lead	1084A
JAN 1N540	400	750	250	0.350	Axial lead	1085A
JAN 1N547	600	750	250	0.350	Axial lead	1083A

*Averaged over 1 cycle for inductive or resistive load with rectifier operating at full rated current at 150° C. ambients.

PRODUCTION QUANTITIES OF ALL TYPES AVAILABLE FOR FAST DELIVERY

Naturally, you can get these new axial lead JAN types direct from AUTOMATIC, and from authorized distributors throughout the country – and at prices that reflect General Instrument's years of volume production experience.

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- **LOW POWER REQUIREMENT** . . . 2.5 watts at 120 vac.
- **COMPLETELY DEPENDABLE** . . . utilizes the well known Haydon Timing Motor.
- **AVAILABLE** . . . for 60 cycle operation at 120 or 240 vac.

The low cost of this new Series ED-71 Elapsed Time Indicator makes it possible to provide an economical, accurate record of operating time for machine tools, communications equipment and practically any other type of industrial or commercial installation. Insures accurate scheduling of maintenance, tool changes and parts replacement. Helps to keep operating efficiency at a maximum . . . operating and maintenance costs at a minimum. Other Haydon Elapsed Time Indicators of similar size and weight are available for military applications.

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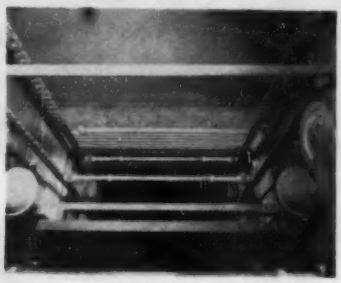
HEADQUARTERS FOR TIMING

include: better control over material degradation than with liquid development; triple processing speed; better quality control; materials savings due to the closed system; greater product uniformity; more suited to continuous flow production; less dropouts due to handling; no sewerage problem. The resist is completely hardened as the work leaves the machine.



Looking down into vapor tank of developing machine

Typical product manufactured at Stromberg-Carlson by photo etch process

During test runs, various types of rejects appeared. One cycle through the machine should result in visible, clearly defined, multiple circuits on the copper clad sheets.

Unremoved photo resist residue (incomplete development) can be caused by lack of spray, plugged nozzles, improper spray adjustment or excessive resist coating. Remedies would be opening solvent valves, unplugging spray nozzles, checking spray pattern and solvent line pressure, or adjustment of resist spray apparatus, respectively.

Poorly defined circuits can be corrected by checking the machine's functioning. Shifting of photo resist pattern may be caused by underexposure of the resist, incomplete resist drying or too heavy a coating, or poor adherence of the resist to the copper. Remedies are increasing exposure time, adjusting sensitizing operation, or insuring

Industry's most adaptable—most versatile general duty plug and receptacle line . . . for power, control, electronic and thermocouple circuits in U/L circuit breaking ratings up to 20 amperes 250 volts, D.C.—460 volts, A.C.

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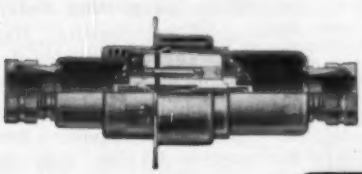
Pyle-National's Triploc is the finest line of connectors on the market today, in its electrical rating and general application class. In the Triploc compact size and price range, no other connector can approach its rugged construction for industrial service . . . or equal the hundreds of optional shell assembly combinations possible with the standard 1 to 12 pole interchangeable and reversible contact inserts. Combinations up to 48 poles are easily assembled in enlarged shells which gang 2, 3 and 4 standard inserts. Water-tight shells also 2-wire and 3-wire fusible plugs are available.

New, Enlarged Wiring Space. Triploc's cadmium plated, pressed steel shells are of strong, low-weight design and provide ample wire terminating space for all inserts.

Self-Locking Triploc Plugs are available with automatic cord-strain release or with manual twist release only.

Wide Choice of Wire Terminals. Contact inserts are available with binding screw terminals—back wired, side wired, or pressure eyelet type; solder well type; crimp type.

Midget Triploc Round Prong Series is available in 2, 3 and 4-pole ratings of 20 amperes, 125 volts A.C.; 15 amperes, 125 volts D.C.; 10 amperes, 277 volts A.C.



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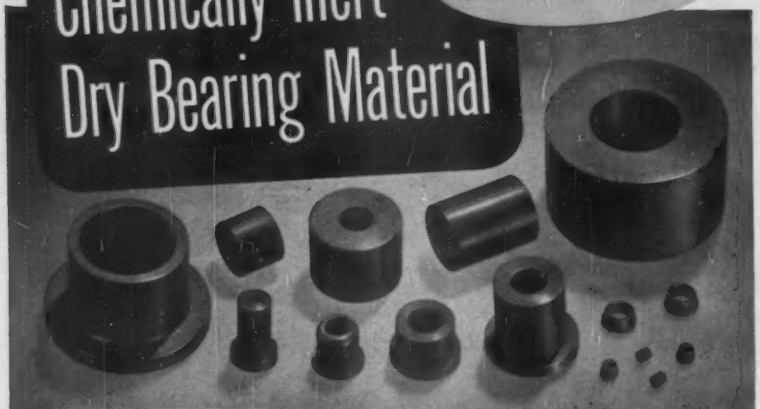
Chemloy 719



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Chemloy 719 is proving to be the most *universal* dry bearing material ever offered to industry:

...because its extremely low coefficient of friction invites use where lubrication is impossible, impractical or undesirable.

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... because it is impervious to practically all known chemicals, solvents or corrosives.

... because it is excellent under vibration or shock service conditions.

... because it will not conduct electricity or cause galvanic corrosion.

Chemloy 719 is available in all basic forms—such as sheet, rod or tubing—or in parts molded or machined to specifications. Get full details.

Request Bulletin T-120 and Price Sheet No. 126, or send b/p or specs. for quotation on molded or machined parts.

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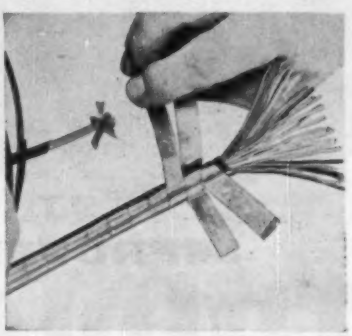
that copper is clean enough.

If the trichlorethylene attacks the phenolic base, the material does not meet specifications and should be rejected. Tests of insulating materials used showed that all could withstand at least a 4 minutes and 10 seconds exposure. The most complete and descriptive results were obtained with surface and volume resistivity tests performed per ASTM D257 under conditions ASTM D618, condition C, using an EIA test pattern. Excessive exposure to the vapors will degrade base materials. XXXP cold punching phenolics are the most readily attacked.

It has been found that the same machinery and techniques can be used for other printed wiring production operations, such as silk screen and offset printing ink resist removal, or other degreasing applications.

Wrapped Cable Shield

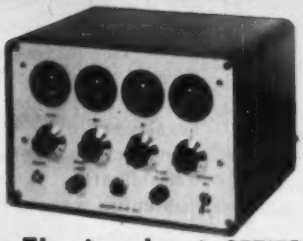


BI-DIRECTIONAL Netic Co-Netic foil strips, applied to cable in contraspiral wraps, provide magnetic and electrostatic shielding. Cable retains flexibility and will not pickup or radiate, permitting closer positioning of components. Manufacturer, Magnetic Shield division, Perfection Mica Co., Chicago, Ill., says the shielding is not sensitive to shock, is non-retentive and does not require periodic annealing.

Film Finds Stains

HARD-TO-SEE CONTAMINATION can be detected by a photographic technique. Panchromatic emulsions, used in conjunction with colored light, are sensitive to variations in surface absorption and consequent

NEW Veeder-Root Counters



New Electronic Predetermining Counters

SERIES 1604

These counters are ideal for batch control, sequential predetermining, or accurate length control in such applications as packaging, coil winding, slitting, stacking and material handling.

A versatile group of transistorized electronic predetermining counters designed particularly for industrial applications. These units will operate at speeds up to 5,000 counts per second, with automatic recycling at speeds up to 1,000 counts per second. A photohead to actuate the counter can be designed to fit specific applications.

Units can be easily operated by non-technical personnel. The preset quantity can be established quickly at any point within the range of the counter by means of the large selector knobs. Any number of decades can be furnished.

Dual sets of presetting controls for sequential predetermining, or accurate length control in such applications can be furnished on request.

This is your complete package for predetermining counting at high speeds.

For complete details on these units, write today!

Count-PAK

SERIES 1661

Complete electronic counting package for use where high speed, long life and instant reset are required. Highly suitable for high speed direct counting applications such as can and bottle counting or case or piece counting on conveyor lines.

Consists of glow-transfer cold-cathode counting tube and high speed magnetic counter, coupled with transistorized circuits. Photohead designed to your application.

The use of transistors means that heat has been eliminated and no warm up time is required. Unit is completely enclosed in an attractive industrial case to insure long, trouble-free life. Use of an electronic decade increases the life of the electromechanical counter and makes the unit ideal for continuous rugged operation.

Write for complete specifications and prices today!

NEW SERIES 1622

High-Speed Predetermining Counter

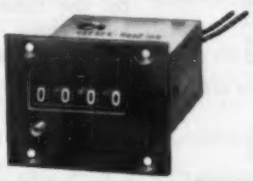
Ideal for high-speed counting requirements such as coil winding, textile spinning frames, and other predetermining counter requirements.

Instant quick-lever reset, plus quick and easy setting of the predetermined number are outstanding features of this counter. Measures approximately 2.6" wide, 5" long, 2.8" high. Speeds up to 6,000 RPM or 8,000 CPM are maximums recommended.

Easily preset to the required number of pieces or performance-units, the counter subtracts to zero. Resetting returns wheels to original preset number. This new counter meets standard U. S. electrical requirements (JIC Codes) . . . and is available with either electrical switch or mechanical stop. Also available without the predetermining feature, as a high speed reset revolution counter.

Also available as a high-speed revolution counter without predetermining feature.

Write for complete information today!



SERIES 1591

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These new compact panel-mounted high speed counters are ideal for D.C. applications requiring accuracy, long life at high speeds and small panel presentation. Counters are suitable for industrial data processing, laboratory and scientific or instrument applications. Available with four or six figures with remote electrical or manual (push button) reset. 3,000 counts per minute recommended speed.

Counters can be connected in series with any device having a contact arrangement. For optimum operation, 60% contact time is required.

Panel Area: 4-figure Counter — 1.7" x 2.1"
6-figure Counter — 1.7" x 2.8"

Available for 6, 12, 24, 48 and 115 volts D.C. operation. For A.C. operation suitable electrical components must be added externally. Reset voltages available are 6, 12, 24, 48, 115 and 230.

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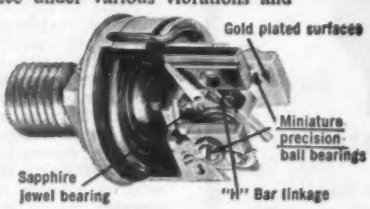
...as small as a bumble bee, but can take shock, acceleration and vibration like no other pressure transducer its size. It was designed specifically for airborne instrumentation to meet the most stringent environmental requirements. Output signal resolution is less than 0.25% with single or dual wire wound potentiometer pick-off.

The excellent performance under environmental conditions is due to an improved "H" bar linkage between the diaphragm push rod and the potentiometer wiper arm which permits the moveable parts to be statically and dynamically in balance under various vibrations and accelerations.

Fairchild's line of Pressure Transducers include bourdon tube and capsular diaphragm types for measuring pressures from 1 to 10,000 psi, absolute, gauge, or differential. Standard units have pot pick-offs; a.c. type pick-offs available on special order.



SPECIFICATIONS AND CHARACTERISTICS			
Vibration	10 to 55 cps, 0.1" da; 55 to 2,000 cps 15g. Error less than 1%. Will withstand 25g, 10 to 2,000 cps.	Pressure Range	0-5 psi to 0-350 psi a, g or d.
Acceleration	40g in 3 planes; error less than 1%. Withstands 75g.	Linearity	±1.0%
Shock	50g without damage or permanent calibration shift.	Size (Volume)	¾ cubic inch (1" dia x 1" long)
		Temperature	—54°C to +100°C. Error less than 1% for most ranges.

For more information write Fairchild Controls Corporation, Dept. 23E

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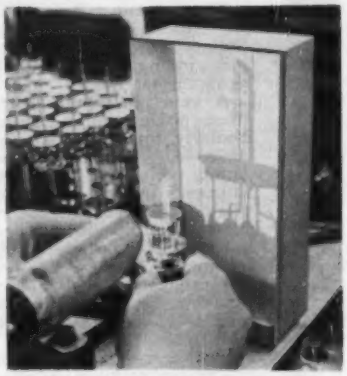
reflection of a particular spectrum band. For example, the following method is used at the Westinghouse Electric Corp. tube plant, Elmira, N. Y., to detect bichromate or chromic acid stains on metallic parts. The surface is photographed through a blue or magenta filter. Stained areas show up light on the negative of a fine grain film. Technique can locate obscure sources of contamination of tube parts, thus tightening process control.

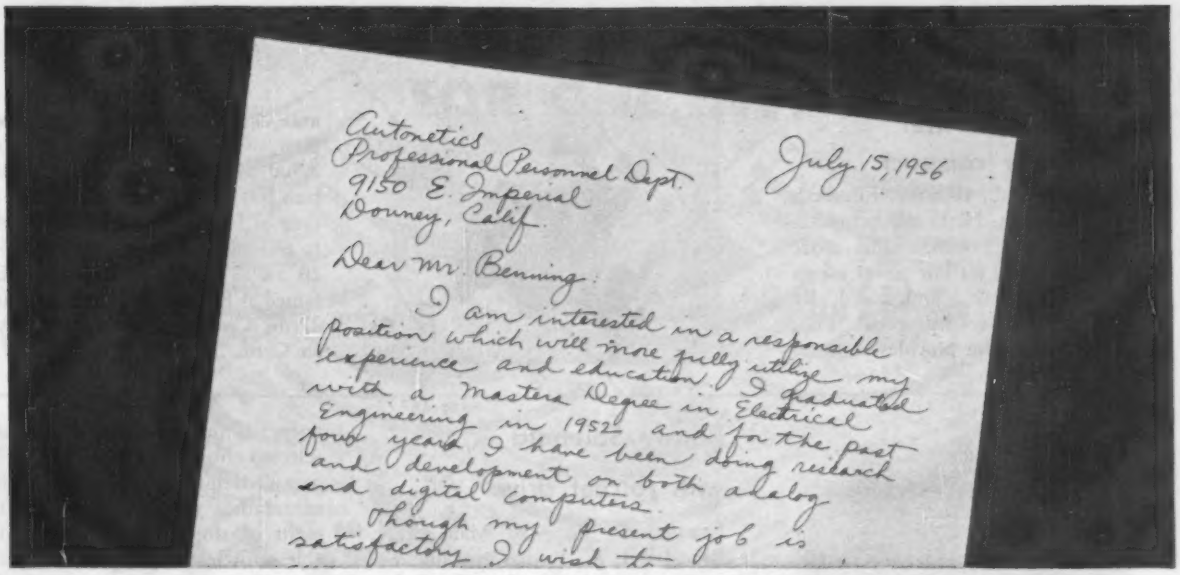
Shadow Checks Tube Structure Alignment



HOME-MADE shadow box is used to visually check the anode-to-filament centering of high voltage rectifiers at the General Electric tube plant in Tell City, Ind. The shadow cast by the tube structure provides a quick check of tolerances when it is compared with an outline, drawn on white cardboard, of the required centering. Tube shown is an 1J3. The holder uses a spring in the shape of a notched ring to hold the tube mount rigidly in the locating fixture. Cone-shaped holes are used to guide the 0.040 inch stem into a 0.050 inch recess. Light is a 10 w concentrated arc lamp, C10/DC.

Machine Zips up Cable

CABLING MACHINE which cables up to 108 conductors at speeds up to 900 feet an hour in 24 square feet of floor space is announced by Zippertubing Co., Los Angeles, Calif. The machine draws conductors from a bank of supply reels and encloses the assembled cables in jackets of metal, plastic, glass or laminations. The jacketing has a zipper closure and may also be chemically sealed.


Autonetics
Professional Personnel Dept.
9150 E. Imperial
Downey, Calif.
July 15, 1956
Dear Mr. Benning:
I am interested in a responsible position which will more fully utilize my experience and education. I graduated with a Masters Degree in Electrical Engineering in 1952 and for the past four years I have been doing research and development on both analog and digital computers.
Though my present job is

This letter moved an engineer ahead 5 years

Two years ago a man took 10 minutes to write this letter. Today he enjoys the responsibility and professional standing in the Autonetics Division of North American that might have taken 5 years to achieve elsewhere.

THE 20TH CENTURY'S MOST INTERESTING OPPORTUNITIES FOR THE CREATIVE ENGINEER

Now under way at Autonetics are over 100 projects—military and non-military—involving some of the most arresting and advanced work to challenge the engineering mind today.

WHERE IS YOUR FIELD OF INTEREST?

Inertial Navigation Systems—for aircraft and naval vessels with the organization that successfully flew all-inertial autonavigators more than eight years ago—and whose many-generation family of ever-improved inertial systems for manned and unmanned vehicles have made over 800 successful flights.

Radars—like the lightweight, monopulse type that guides aircraft to targets through fog and darkness and provides all radar functions for both high and low level missions—air-search, automatic tracking, ground-mapping and terrain-avoidance.

Flight Controls—fully automatic and reliable autopilots and landing systems.

Information Processing Equipment—including airborne magnetic tape recorders, transistorized analog or digital computers for both the military and industry, and pace-setting numercial control systems for three-axis position and path control of machine tools for industry.

At finger-tip nearness Autonetics has unique experience, advanced tools and techniques plus precision machine shops turning out work to millionths of an inch tolerances in both developmental and volume quantities.

Opportunities have never been better—at every level of creative engineering from Preliminary research and design to Performance test—**because Autonetics is one of the few companies in the world** designing and quantity-producing systems within the complete spectrum of electronics, electro-mechanics, control engineering and data processing.

Write today and tell us what kind of creative engineering interests you (please include highlights of your education and experience).

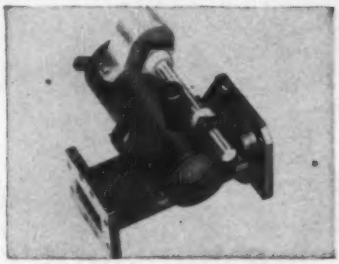
Write C. L. Benning, Manager, Employment Services.
9150 E. Imperial Highway, Downey, California

Autonetics
A DIVISION OF NORTH AMERICAN AVIATION, INC.

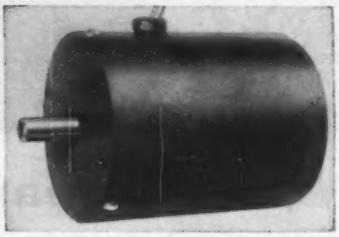
NERVE CENTER OF THE NEW INDUSTRIAL ERA

NEW PRODUCTS

Dual Mode Filter
extremely compact



AIRTRON, INC., 1096 W. Elizabeth Ave., Linden, N. J. An extremely compact single-section dual mode filter designed for low power use in X-band systems is announced. By employing two orthogonal TE_{111} modes, this filter provides performance equalling that of a two-section filter. Tuning range covered is 8,500 to 9,600 mc, with an insertion loss of less than 1.0 db and a vswr of less than 1.20. Bandwidth to the 3db points is approximately 20 mc at midband. Rejection obtained at $F_o \pm 60$ mc is greater than 27 db. **Circle 300 on Reader Service Card.**



Rotary Solenoid
with ratchet drive

LEETRONICS, INC., 30 Main St., Brooklyn 1, N. Y., has available a ratchet drive, rotary solenoid called the Motoroid. Featuring a new design that provides rotary output without the use of linkages, the output torques of the units can be selected from any part of their over-all torque curve and the angle of rotation varied by the adjustment of stops. Models are available with left or right hand rotations for continuous or intermittent duty. The ratchets are available for 10 and 15 deg increments. **Circle 301 on Reader Service Card.**

Silicon Rectifier
high temperature

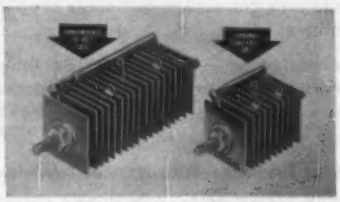
TRANSITRON ELECTRONIC CORP., Wakefield, Mass. The TM155 silicon rectifier offers 1,500 v, 400 ma ratings at 150 C case. It may be used in h-v power supplies for magnetrons, klystrons, electronic precipitators and other applications requiring 600 v output or higher. Unit is hermetically sealed in the standard $\frac{7}{8}$ in. hex package, and is resistant to shock, vibration and environment changes. **Circle 302 on Reader Service Card.**

Copper Strip
resin backed

REDEL INC., 220 N. Atchison St., Anaheim, Calif. Printed circuits can now be prototyped faster and at 10 percent of the cost of the conventional procedure with the use of Cir-Quik, a new resin backed copper strip. No messy chemicals, no fumes, no size limitations, no silk screening or photography is required. Cir-Quik is easily applied to any plastic laminate with regular soldering irons. The resulting circuits can be punched, drilled, and solder dipped without damage. **Circle 303 on Reader Service Card.**

Selenium Rectifier
60-volt cell

INTERNATIONAL TELEPHONE AND TELEGRAPH CORP., Clifton, N. J., announces a 60-v selenium rectifier cell. The line includes cell sizes of 1 in., $1\frac{1}{4}$ in., $1\frac{1}{2}$ in. and 2 in. with single phase bridge rating of 150 ma, 300 ma, 600 ma and 1 ampere. Features of the line are miniature size, high efficiency, low temperature rise, proved mechanical construction, and reliable operation at high temperatures. **Circle 304 on Reader Service Card.**



Silicon Rectifiers
axial lead type

NORTH AMERICAN ELECTRONICS, INC., 212 Broad St., Lynn, Mass., has available the NL line of low-cost, general purpose axial lead silicon rectifiers designed for efficient operation in ambient temperatures up to 100 C. Average output cur-

THIS MAY SEEM LIKE A LOT OF SCALES FOR *ONE* INSTRUMENT...

THAT'S WHAT YOU GET In the *RADICALLY NEW* SENSITIVE RESEARCH INCREMETER*

***By definition—A DIRECT READING DC ELECTRICAL INDICATING INSTRUMENT with an *EFFECTIVE SCALE LENGTH OF 63 INCHES* and an ACCURACY OF .05%.**

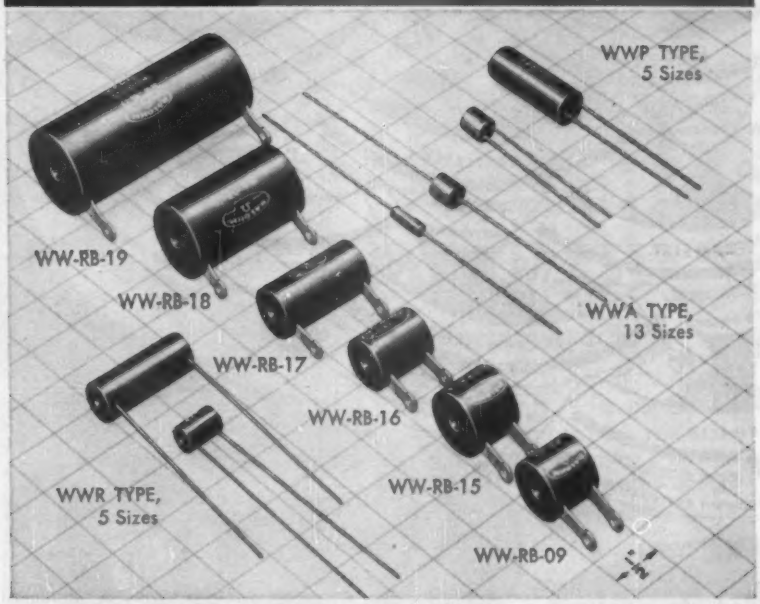
The Model INCRE essentially consists of a differential instrument of "high comparison accuracy" and a stable "high accuracy" reference source. The instrument's actual scale length is 6.3", but this represents only 10% of its total effective scale length. Each 10% of its full scale range is selected by an incremental switch in effect creating a 90% scale suppression at all times. ***Ranges*** — single or multirange from 200 mv. full scale (lowest reading .2 mv.) and 200 microamperes full scale (lowest reading .2 microamperes). ***Resolution*** — effectively 1,000 scale divisions over a 63" scale length. Each scale division has a value of .1%. ***Availability*** — portable or as a rack-mounted edgewise panel instrument. **The SRIC Differential "63" Incremeter** is a high resolution, *phenomenally* accurate measuring device with proven stability because it *is* an Electrical Indicating Instrument. **Diamond Pivoted of course!**

Write for additional information on the *NEW* "INCREMETER".

SENSITIVE RESEARCH INSTRUMENT CORPORATION

DALOHM Ω

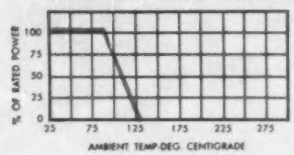
...for Complete Reliability Under Severe Environmental Conditions



TYPE WW HIGH RESISTANCE RESISTORS

Wire Wound, Precision, Hi-Value, Non-Inductive

TYPICAL DERATING CURVE



JUST ASK US

The DALOHM line includes precision resistors and trimmer potentiometers (wire wound and deposited carbon); resistor networks; collet fitting knobs and hysteresis motors designed specifically for advanced electronic circuitry.

If none of the DALOHM standard line meets your needs, our engineering department is ready to help solve your problem in the realm of development, engineering, design and production.

Just outline your specific situation.

DALE PRODUCTS INC.
1300 28th AVE.
COLUMBUS, NEBRASKA

High resistance value, wire wound resistors designed for non-inductive requirements that demand the closest precision tolerance. Encapsulated in carefully compounded material, selected for matching coefficient of expansion to that of the wire.

- Rated at .1 watt to 2 watts, with a wide selection, depending on type and size.
- Resistance range from 0.6 ohm to 6 Megohms, depending on type.
- Tolerance: ± 0.05%, ± 0.1%, ± 0.25%, ± 0.5%, ± 1%, ± 3%.

TEMPERATURE COEFFICIENT: Within 0.00002/degree C.

OPERATING TEMPERATURE RANGE: −55° C. to 125° C.

SMALLEST SIZES: ⅛" x ⅜" to 2⅛" x ⅞"

COMPLETE PROTECTION: Encapsulating material makes them completely impervious to penetrating effects of salt spray, humidity, moisture and corrosive gases and vapors.

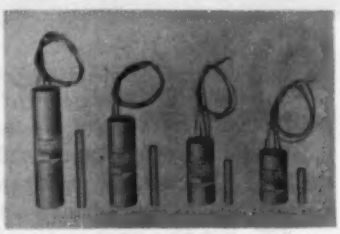
CONFIGURATIONS: WWA — axial leads; WWP—parallel leads; WWR—radial leads; WWL—lug style terminals; WW-RB—military style with lug terminals; HWA and HW-RB—high temperature applications.

MILITARY SPECIFICATIONS: Surpasses MIL-R-93B, characteristic A and B; MIL-R-9444.

rent rating is 500 ma at 100 C with piv's from 50 to 500 v. The rectifiers are priced from 40 cents each in production quantities. **Circle 305 on Reader Service Card.**

Rectifier Analyzer versatile unit

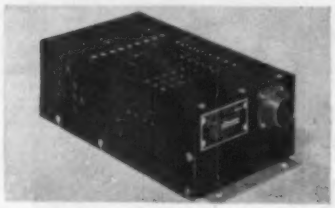
CEDCO ELECTRONICS, INC., Erie, Pa. New precision test equipment rapidly performs five standard circuit tests for silicon, germanium and selenium metallic power rectifiers and signal diodes. The metallic rectifier analyzers provide both visual and metered testing. Designed for production lines and laboratories, they perform the following circuit tests up to and including the 5 ampere size rectifiers: visual dynamic voltage-current characteristics; dynamic reverse current-leakage; dynamic forward voltage-drop; static reverse current-leakage; and the static forward voltage-drop test. **Circle 306 on Reader Service Card.**



Transformer doubled range

SCHAEVITZ ENGINEERING, Route 130 & Schaevitz Blvd., Pennsauken, N. J. Differential transformers generally have their zero or null position at the mid-point of core travel, with the result that core displacement on either side of

the null involves a 180-deg phase change. In many applications only one direction of core movement can be utilized, thus wasting half the transformer range. The company has developed a single ended linear variable differential transformer with null position at the end and a full linear range. The new construction makes it possible to obtain a single-ended range approximately twice that of a conventional transformer of similar size. **Circle 307 on Reader Service Card.**



Static Inverter transistorized

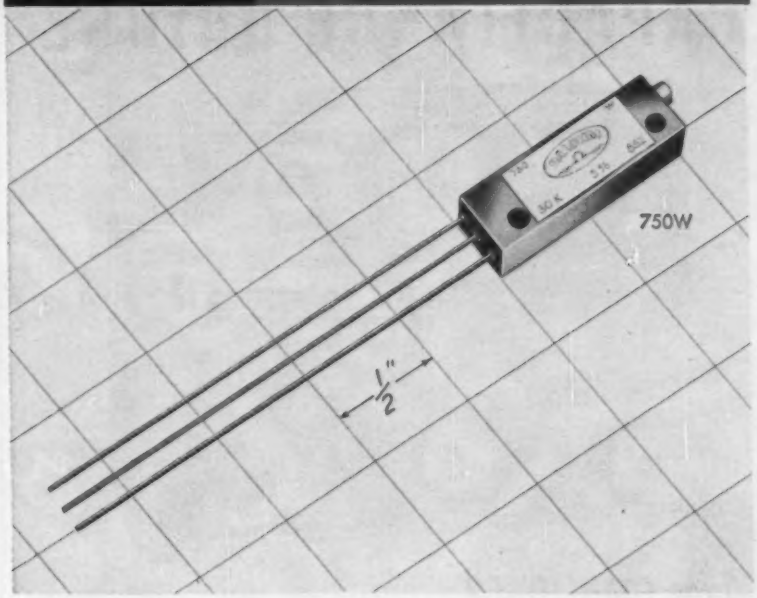
VARO MFG. CO., INC., 2201 Walnut St., Garland, Texas. Model 4309 static inverter produces both single and three phase 400 cycle power from 28 v d-c input. A bimetallic tuning fork reference controls the frequency to 400 cps ± 0.1 percent over the environmental range of − 55 C to + 71 C. Utilizing transistors in a bridge switching circuit for maximum reliability, 170-200 va of single phase power and approximately 50 w 3-phase power are obtained from a unit weighing only 9½ lb. **Circle 308 on Reader Service Card.**

Indicating Lights meet MIL specs

THE SLOAN CO., 4101 Burbank Blvd., Burbank, Calif., is manufacturing Color-Lite subminiature incandescent indicating lights for indicating and warning circuits in computers, data recording and control instruments, and aircraft con-

DALOHM Ω

...for Complete Reliability Under Severe Environmental Conditions



TYPE 750 TRIMMER POTENTIOMETERS

Super-Miniature, Wire Wound, Precision

Designed for advanced electronic circuits where it's mandatory to meet demanding conditions of miniaturization, reliability, precision and severe operating conditions. This new trimmer offers outstanding performance without sacrificing limited circuit area.

Two terminal styles available: 750W —with leads extending from end of case. 750P — with leads extending from bottom of case for printed circuits.

- Rated at 2 watts, up to 70° C. ambient.
- Resistance range from 100 ohms to 30K ohms.
- Standard tolerance: ±5%, closer tolerance available.

OPERATING TEMPERATURE RANGE: −55° C. to 175° C.

SUPER-MINIATURE SIZE: .180 x .300 x 1.00 inches.

RESOLUTION: .1% to 1%, depending on resistance.

SHAFT TORQUE: 5 inch/ounces.

BACKLASH: 10° maximum.

SCREW ADJUSTMENT: 18 turns, nominal.

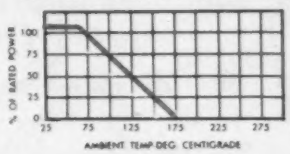
MOUNTING: Individually or in stacked assemblies with standard 2-56 screws.

SAFETY CLUTCH: Clutch arrangement on moveable wiper contact prevents breakage due to over-excursion.

WEIGHT: 2 grams.

MILITARY SPECIFICATIONS: Surpass applicable paragraphs of MIL-R-19A, MIL-R-12934A, MIL-E-5272A and MIL-STD-202A.

TYPICAL DERATING CURVE



JUST ASK US

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If none of the DALOHM standard line meets your needs, our engineering department is ready to help solve your problem in the realm of development, engineering, design and production.

Just outline your specific situation.

DALE PRODUCTS INC.
1300 28th AVE.
COLUMBUS, NEBRASKA

Unique PRECISION CAPACITANCE BRIDGE

Type CMB1/OSF2

RANGE: 0.001 μμF to 1.111 μF.

ACCURACY: 0.1% + 0.005 μμF above 0.1 μμF
0.0005 μμF below 0.1 μμF.

Frequency Range: 200 cps to 5 kc.
Power Factor Range: 0 to 100 · 10^{-3} (at 1 kc).

- **Wide range and extremely high accuracy.**
- **Measures directly single capacitances from complex capacitance networks.**
- **Shielded cables used without introducing errors.**
- **Built-in oscillator, detector, and balance indicator.**

Radiometer, a leading Scandinavian instrument manufacturer with a world wide service organisation, offers a line of 50 different instruments such as:

AF-OSCILLATORS
R-L-C BRIDGES
STANDARD-SIGNAL GENERATORS
VACUUM-TUBE VOLTMETERS
WAVE ANALYZERS
ELECTROCHEMICAL INSTRUMENTS

Write for complete information.

RADIOMETER

72 EMDRUPVEJ, COPENHAGEN NV, DENMARK

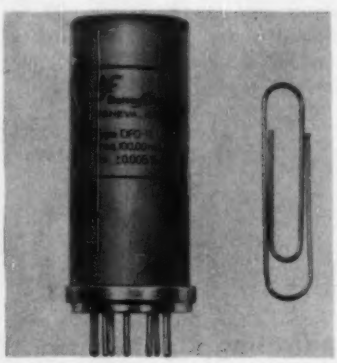
Represented in the United States by
WELWYN INT. INC.
3355 Edgecliff Terrace Cleveland 11 Ohio

Represented in Canada by
BACH-SIMPSON
London/Ontario

trol panel applications. The low cost, full 180 deg visibility lights meet MIL specs and are designed also for use in printed circuit boards, missile control and test stand systems, shipboard use and for applications in petroleum field test stations. **Circle 309 on Reader Service Card.**

Voltage Regulator transistorized

VALOR INSTRUMENTS, INC., 13214 Crenshaw, Gardena, Calif. A small, compact voltage regulator provides voltage regulation, low output impedance and variable voltages from fixed voltage unregulated d-c supplies. It is available with either fixed or variable voltage output to operate from a nominal 28 v d-c supply. Output is 6 to 20 v d-c at ½ ampere. Unit uses germanium transistors for regulation and silicon zener diodes for reference. **Circle 310 on Reader Service Card.**



Miniature Oscillator wide frequency range

DELTA-F INC., 113 E. State St., Geneva, Ill., has a miniature oscillator package available at any specified frequency in the range from 8 to 100 mc. A completely

FOR RADAR
AND NAVIGATION

VARIAN KLYSTRONS
AND WAVE TUBES

VA-87 B.C.

HIGH GAIN, HIGH POWER, HIGH EFFICIENCY

You get all three in a single Varian Klystron, as in the VA-87B or C. These tubes are stable amplifiers, . . cover a wide frequency range without critical adjustments of operating voltages and magnetic focusing. Features include rugged integral cavities, easy "plug-in" installation . . . outstanding reliability and long life.

Varian Microwave high power tubes are available in a wide variety of power output and frequency ranges for use in Radar, Communications, Test and Instrumentation, and many are recommended for Severe Environmental Service. Over 100 tubes are described and pictured in our new catalog. Write for your copy.

VARIAN associates
TUBE DIVISION
PALO ALTO 1, CALIFORNIA
Representatives in all principal cities

VA-87B, C	2.7 to 3.5 kMc	2 MW Peak
V-62	3.3 kMc	7 MW Peak
V-268	9.375 kMc	40 kW Peak
VA-816J	3.40 to 3.57 kMc	2½ MW Peak

KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS,

It's just part of the Victoreen story...

Victoreen Corona Type Voltage Regulators are approved by the military.

Superior voltage regulation and greatly extended current ranges—that's *part* of the Victoreen story. But it doesn't stop there. Use of these new glass or metal corona regulators means you can eliminate complex circuitry regulators. Fail-safe feature gives protection not afforded by other forms of regulators.

Improved Regulation results from new electrode structures and improved processing for greater dynamic resistance, greater protection, simplified circuits.

Improved Current Rating increases scope of applications.

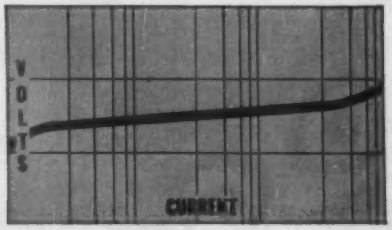
Improved Life Expectancy results from even better processing, even more rigid selection of materials.

Improved Ruggedization means these regulators withstand more rigorous adverse environments longer.

AA-5421

Get the full story on the new Victoreen voltage regulators.

Write for your free copy of Form 3003-7 today.



The Victoreen Instrument Company
Components Division
5806 Hough Avenue, Cleveland 3, Ohio

encapsulated circuit, the package diameter is only 0.75 in.; seated height, 1¼ in. The DFO-11 has a plug-in noval base and can be retained in socket mounting with conventional tube shield. Operating temperature range is −55 C to +75 C; also available, −55 C to +105 C. Frequency stability is ±0.005 percent. Output power is 0.1 to 1.0 mw depending upon frequency. Output impedance to specifications: 50 to 1,000 ohms typical. Supply voltage as specified (6 to 30 v typical). **Circle 311 on Reader Service Card.**

D-C Power Supply

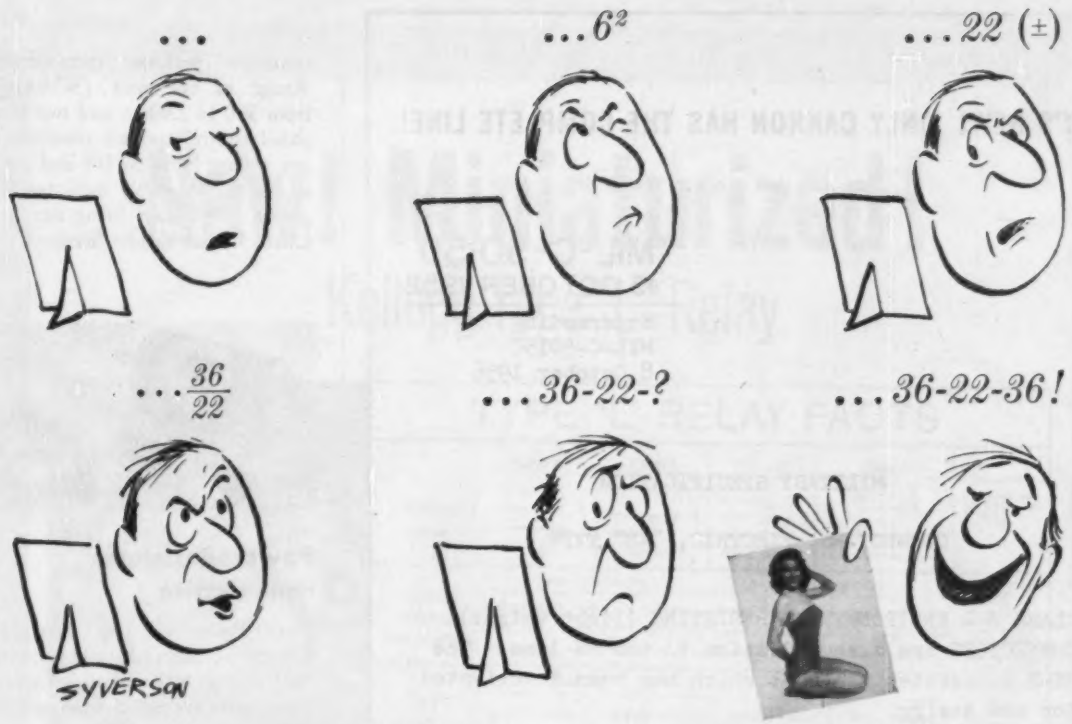
high regulation

Owen Laboratories, Inc., 55 Beacon Place, Pasadena, Calif., has announced two new a-c to d-c high regulation, floating power supplies. The compact, lightweight and portable 1-40 v d-c units are designed for energizing resistance type transducers and transistorized circuitry, requiring a well regulated source. Both the type 550 (0-1.1 ampere) and the type 551 (0-2.5 ampere) d-c power supplies offer long term stability of 0.02 percent and have resolution of less than 2 mv. **Circle 312 on Reader Service Card.**

H-V Power Supply

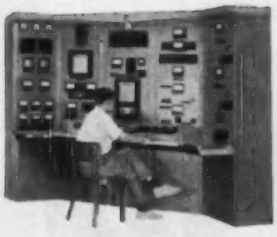
for spectrometry

Tracerlab, Inc., 1601 Trapelo Road, Waltham 54, Mass. A new h-v power supply is designed specifically to meet demands of researchers and organizations that



What's the size of your design problem? Facing a multiplicity of project details? It's no laughing matter when you're caught short-handed on a critical design program. You need proved engineering ability **plus** systems capabilities you can count on. Next time... **this time**—

LOOK TO INET FOR UNIQUE DESIGN CAPABILITIES



Here's another example of INET capability: the console, recorders and related instruments built, installed and wired by INET for Atomics International's L-54 nuclear research reactor. The solution-type L-54 reactor, which has a rated power capacity of 5,000 watts, was designed and built by Atomics International for the West Berlin Institute for Nuclear Research. It is being used for German scientific, medical and industrial research.

Engineers desiring a special reprint of the cartoon above should write to "36-22-36," % Inet Division, Leach Corporation.

INET DIVISION LEACH CORPORATION

18435 SUSANA ROAD, COMPTON, CALIFORNIA

DISTRICT OFFICES AND FIELD REPRESENTATIVES IN PRINCIPAL CITIES OF U. S. AND CANADA
EXPORT: LEACH CORPORATION, INTERNATIONAL DIVISION

IT'S NEW! ONLY CANNON HAS THE COMPLETE LINE!

MIL-C-5015D
15 OCTOBER 1958

Superseding
MIL-C-5015C
8 October 1956

MILITARY SPECIFICATION

CONNECTORS, ELECTRIC, "AN" TYPE

CLASS R - ENVIRONMENTAL RESISTING (light weight) CONNECTORS are a new addition to the MS line. The MS-R supersedes the MS-E which has been inactivated for new design.

Cannon is the only qualified source for the complete line of the new class MS-R connectors.

"Class R connectors are intended for use where the connector will be subject to heavy condensation and rapid changes in temperature or pressure, and where the connector is subject to very high vibratory conditions."

MIL-C-5015D specifies that Class R connectors shall have "the wire sealing grommets in firm contact against the rear face of the insert." This requirement, now written into the specification, has always been a Cannon design criterion for all MS environmental resistant designs.

Although the MS-R now supersedes the MS-E "for new design", Cannon Plug Series MS-E (Series ME) and MS-E (Series CT) will continue to be available.

For information on the new MS-R Cannon Plugs write for Catalog MS-ER-4 - Refer to Dept.120.

CANNON PLUGS

Cannon Electric Co. 3208 Humboldt St., Los Angeles 31, Calif.

CAM-3-MIL

routinely perform spectrometry. Range of the unit (SC-64) is from 500 to 2,000 v and two front panel controls permit selection of any voltage between 500 and 2,000 v. An 0-2 kv meter indicates at a glance the voltage being supplied. **Circle 313 on Reader Service Card.**

Power Resistors noninductive

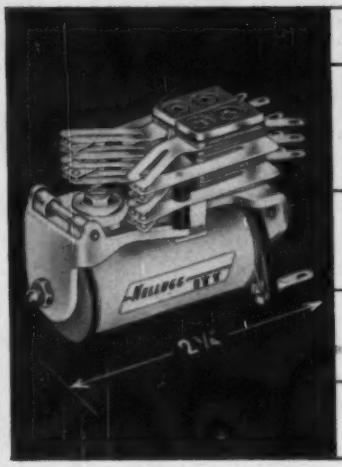
DALE PRODUCTS, INC., Box 136, Columbus, Nebraska. The noninductive type NH wirewound power resistors are specifically designed for high frequency and other applications where noninductive requirements are coupled with power demands. They are completely sealed for protection from humidity and salt spray. There are four sizes in the new line—10 w, 25 w, 50 w and 250 w. Operating temperature range is −55 C to 275 C. Complete specifications and data are given in bulletin R-33. **Circle 314 on Reader Service Card.**

Temperature Indicator for jet aircraft

B&H INSTRUMENT CO., INC., 3479 W. Vickery Blvd., Fort Worth 7, Texas, announces a miniature, potentiometric, precision, combination digital-and-dial temperature indicator. The AutoTemp is used to measure turbine inlet temperature or exhaust gas temperature. Weighing 1.75 lb, measuring 3 in. diameter by 7 in. overall length,

New! Miniaturized!

Kellogg Type "L" Relay



TYPE "L" RELAY FACTS

CONTACT FORMS	FORM A (MAKE)		FORM B (BREAK)		FORM C (BREAK-MAKE)		FORM D (MAKE BEFORE BREAK)			REMARKS: 12 SPRINGS MAX. PER STACK. ONE FORM D MAX. PER STACK.
CONTACT RATING (NON-INDUCTIVE)	TWIN CONTACTS				SINGLE CONTACTS					RATINGS PERTAIN TO CURRENT CARRYING CAPACITY UNDER NORMAL CONDITIONS. SPECIAL APPLICATIONS USUALLY REQUIRE ENVIRONMENTAL TESTING.
	PALLADIUM .062"x.020" 4 Amps. 150 Watts		GOLD .062"x.020" 1 Amp. 150 Watts	SILVER .062"x.020" 2 Amps. 100 Watts	PALLADIUM .093"x.031" 4 Amps. 450 Watts		TUNGSTEN .125"x.050" 3 Amps. 450 Watts	SILVER .125"x.050" 4 Amps. 450 Watts		
TIMING (IN MILLI-SECONDS)	STANDARD COILS				SLUG COILS					TIMING VALUES ARE SUBJECT TO FURTHER LIMITATIONS DEPENDING UPON CONTACT ARRANGEMENT AND APPLIED VOLTAGE.
	OPERATE RANGE 3-30		RELEASE RANGE 4-20		OPERATE RANGE 20-60		RELEASE RANGE 30-100			
MISC.	COIL RESISTANCE				WEIGHT		RESIDUALS			
	SINGLE WOUND UP TO 20,000 OHMS		DOUBLE WOUND UP TO 6500 OHMS EACH WINDING		APPROX. 2¼ OZ.		AVAILABLE WITH SCREW OR FIXED TYPE RESIDUALS			

"Compact, lightweight, extremely versatile, *reliable*" . . . these are some of the comments of engineers who have tested Kellogg's new type "L" relay. It is a sturdy re-engineered version of the model used for years in telephone offices around the world. Now, its many new features make it particularly adaptable to industrial applications including computer systems, two-way radio and automation devices.

Efficient design gives the Kellogg type "L" more operating force than relays of comparable size. This means greater sensitivity, gram pressure and more springs per pileup. In addition, the new relay features:

- **rear mounting,** for ease of wiring
- **wide variety of coils** for any circuit requirements; single or double wound
- **bifurcated stationary springs** for independent contact action and high reliability; (single contacts also available)
- **heavy duty bronze** yoke and stainless steel bearing pin insure long life and stable adjustment
- **single or double** arm type armatures available
- **hermetically sealed** models, if desired
- **operating speed:** minimum of 1 to 2 milliseconds
- **contact points:** gold, silver, palladium, tungsten; other materials available
- **residual:** adjustable
- **time delay:** heel-end slugs and armature-end slugs for release time delay and operate time delay, respectively
- **terminals:** slotted
- **weight:** Net, 2¼ oz.
- **dimensions:** 2-1/4" L x 1-1/8" W, ranging in height from 17/32" to 1-1/16" (max.)
- **operating voltages:** up to 220 V.D.C.

Behind the superior reliability and design of Kellogg's type "L" relay are more than 60 years of experience as a leading producer of telephone equipment. And as the communications division of International Telephone and Telegraph Corporation, Kellogg has the research talent of 3500 engineers and technicians at its disposal.

Inquiries are invited. Send for a free catalog on relays and other components manufactured by Kellogg.

Kellogg Switchboard and Supply Company, 6650 South Cicero Avenue, Chicago 38, Illinois. Division of International Telephone and Telegraph Corporation.

KELLOGG Communications Division of IT&T
CHICAGO, ILLINOIS

Manufacturers of: Relays • Hermetically sealed relays • Switches • Solenoids

Ballantine

SENSITIVE ELECTRONIC VOLTMETER

Battery Operated

VOLTAGE RANGE:
100 microvolts to 1000 volts rms of a sine wave in 7 decade ranges.

INPUT IMPEDANCE:
2 megohms shunted by 10 mmfd on high ranges and 25 mmfd on low ranges.

FREQUENCY RANGE:
2 cps to 130,000 cps.

ACCURACY:
3% except 5% below 5 cps and above 100,000 cps
and
for any point on meter scale.

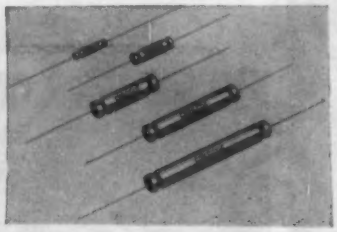
MODEL 302C—Price $245.

- Available accessories increase the voltage range from 20 microvolts to 10,000 volts.
- Available precision shunt resistors permit the measurement of AC currents from 10 amperes down to one-tenth of a microampere.
- Features the well-known Ballantine logarithmic voltage and uniform DB scales.
- Battery life over 100 hours.
- Can also be used as a flat pre-amplifier with a maximum gain of 60 DB. Because of the complete absence of AC hum, the amplifier section will be found extremely useful for improving the sensitivity of oscilloscopes.

For further information on this and other Ballantine instruments write for our new catalog.

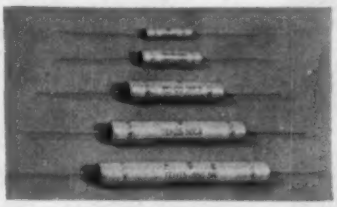
BALLANTINE LABORATORIES, INC.
Boonton, New Jersey

with a guaranteed accuracy of ± 1 deg in a range of 500 C to 1,000 C when calibrated for chromel-alumel thermocouples, the hermetically sealed instrument provides lab accuracy under severe service conditions. **Circle 315 on Reader Service Card.**



Tantalum Capacitors foil-type

SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass., has improved its foil-type tantalum electrolytic capacitors to withstand a 2,000 hr life test, twice the previous standard for this product. In addition to new internal designs, they have a new type of end seal using a TFE-fluorocarbon resin which is virtually leakproof. Technical descriptions are given in bulletins 3601 and 3602, available on letterhead request.



Tantalum Capacitors single-cased units

TANSITOR ELECTRONICS INC., West Road, Bennington, Vt. Type TEH tantalums are −55 C to +125 C small foil capacitors designed for high reliability electronic equipment where temperatures exceed the 85 C normally encountered. They are intended for applications in military and industrial devices such as control equipment, computers, airborne radar, guided missiles, and communication equip-

(Continued on p. 144)

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Certain multi-product advertisements contain Reader Service numbers for each product.

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MEMO:

NEW PRODUCTS RELEASES

TO: ALL MANUFACTURERS

FROM: electronics

electronics publishes all new product items of interest to makers and users of electronic and allied equipment.

The reverse side of this card provides a service to subscribers by facilitating the flow of additional information between manufacturers and our readers.

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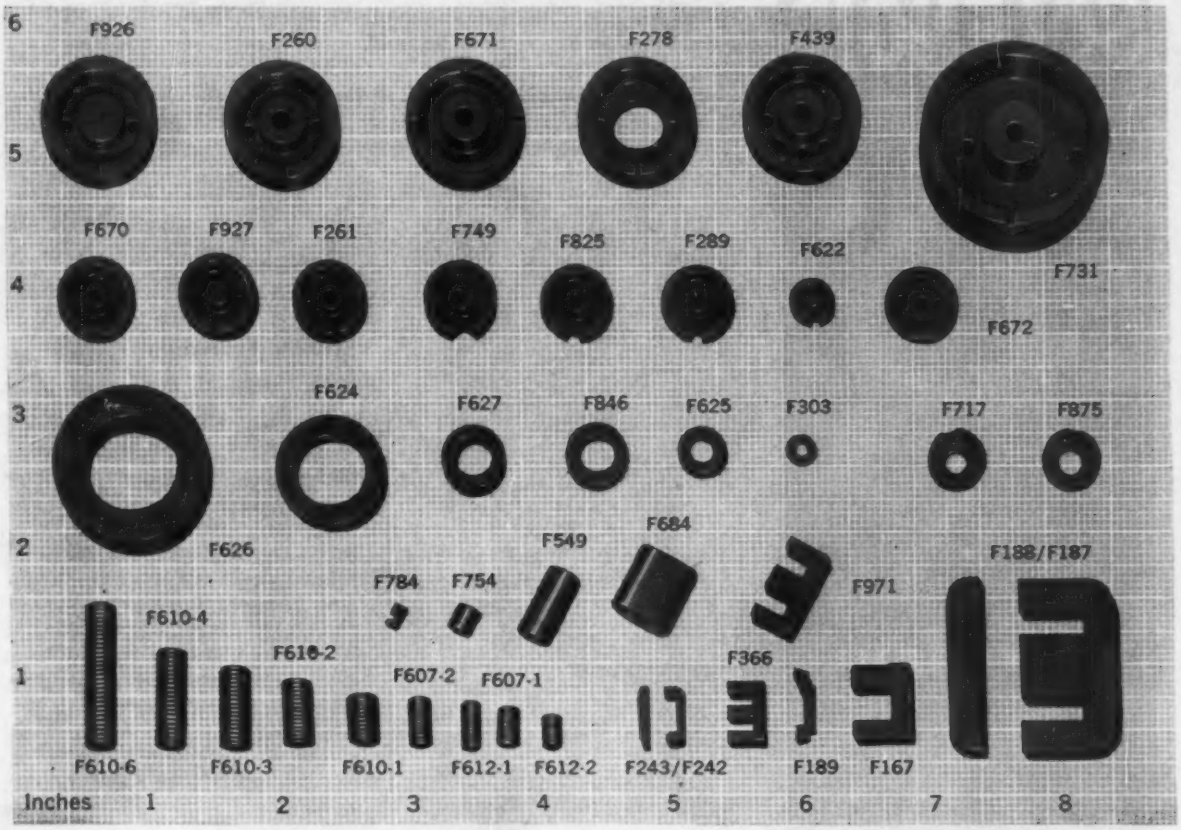
Now, Immediate Delivery from Stock on

GENERAL CERAMICS SPECIAL PURPOSE FERRITE CORES



Rush service for designers – use this handy materials selector chart

Ferrite Cores available in various materials for development and design engineers to cover specific frequency bands of operation from 1 KC to 50 megacycles. General Ceramics provides extra-fast service on sample quantities for development and will make prompt delivery on production parts in reasonable quantities. Call, wire or write General Ceramics Corporation, Keasbey, New Jersey. Please direct inquiries to Dept. E.

APPLICATION	DESIRED PROPERTIES	FREQUENCY	FERRAMIC BODY	SHAPES
Filter Inductors	High μQ, magnetic stability, sometimes adjustable	up to 200 kcs 200 kcs-10 mcs 10 mcs-80 mcs	"0-3", "T-1" "Q-1" "Q-2"	Cup cores, toroids, C-cores, E-cores, slugs
IF Transformers	Moderate Q, high μ, magnetic stability, adjustable	465 mcs 40 mcs other	"Q-1" "Q-2" Materials for filter inductors apply	Cup cores, threaded cores, toroids
Antennae Cores	Moderate Q, high μ, magnetic stability	.5-10 mcs 10.50 mcs	"Q-1" "Q-2"	Rods, flat strips
Wide Band Transformers	High μ, moderately low loss	1 kc-400 kcs 1 kc-1 mc 200 kcs-30 mcs 10 mcs-100 mcs	"0-3", "T-1" "H" "Q-1" "Q-2"	Cup cores, toroids, C-cores, E-cores
Adjustable Inductors	High μ, moderately low loss	Same as Wide Band Transformers	Same as Wide Band Transformers	Rods, threaded cores, tunable cup cores
Tuners	High μ, moderate to high Q, magnetic stability, as much as 10 to 1 arjustability with mechanical or biasing methods	Up to 100 mcs	For high Q selective circuits, materials under filter inductors apply. For others, materials under wide band transformers apply	Threaded cores or rods for mechanical tuning. Toroids, C-cores, E-cores for biasing methods
Pulse Transformers	High μ, low loss, high saturation	Pulse	Materials under wide band transformers apply	Cup cores, toroids, C-cores, E-cores
Recording Heads	High μ, low loss, high saturation, resistance to wear	Audio, pulse	"H" "0-3", "T-1"	

GENERAL CERAMICS

Industrial Ceramics for Industrial Progress... Since 1906

NEW

SOLENOID

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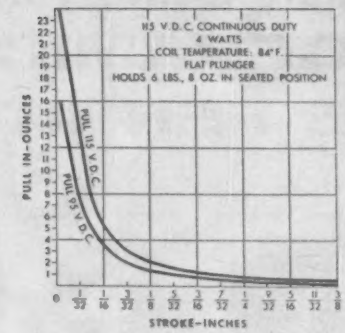
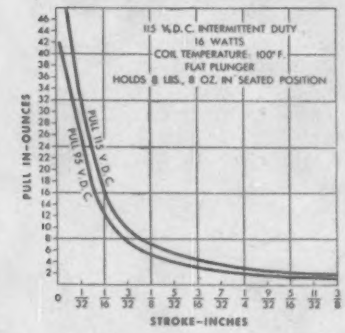
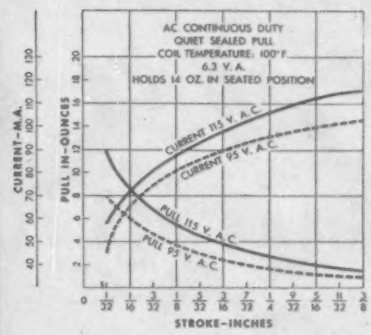
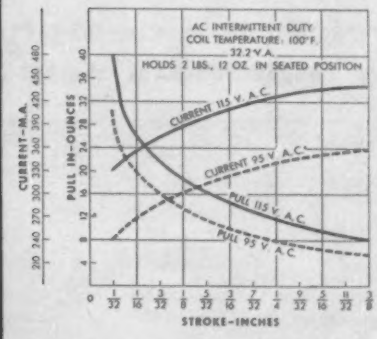
New, economical, compact design. Extremely efficient, dependable in performance. Available for either AC or DC operation, intermittent or continuous duty, 3 to 220 volts. Normally supplied with flat plunger, but also available with conical plunger for DC only. Send for complete details.

Other sizes, solid frame and laminated types, also available.









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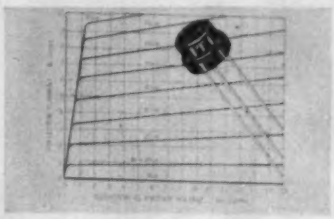
ELECTRIC COMPANY

3349 ADDISON ST., CHICAGO 18, ILL.

RELAYS • SOLENOIDS • COILS SWITCHES • HERMETIC SEALING

ment in general. Units are all single cased, insulated from ground, and supplementary to Transistor Mil C-3965 85C tantalum capacitors. Complete data are available on letterhead request.



Silicon Transistor high-beta

TRANSITRON ELECTRONIC CORP., Wakefield, Mass. A new high-beta silicon transistor offers minimum current gain of 80. A useful beta is maintained even at reduced collector current levels and over a wide range of temperatures, from −65 C to +150 C. The 2N543, 2N542 and 2N541 operate at 45, 30 and 15 v respectively and are ideal for multistage amplifier applications. Offering more gain per stage, these transistors reduce the number of amplification stages required. **Circle 316 on Reader Service Card.**

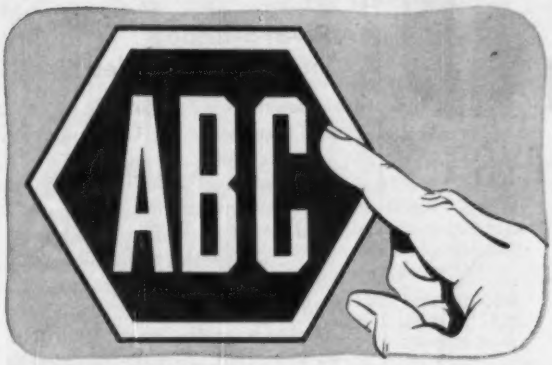
Terminal Blocks for computer uses

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. A group of solderless terminal blocks have been designed for various computer applications and printed circuitry. They accept standard "AMP53" solderless taper pins and are available in any combination of feed-through individual or shorting terminals. Holes are provided for convenient stacking or right angle and perpendicular

Who's Minding The Store?

. . . in the magazine publishing business, it's

The Audit Bureau of Circulations (ABC) is a cooperative organization that sets standards of good business conduct for its publisher members. Once each year ABC auditors carefully scrutinize the entire circulation structure and operation of every member magazine. In a very real sense, therefore, they are "minding the store" — making sure that no false or misleading claims are made regarding the size or composition of a magazine's audience.



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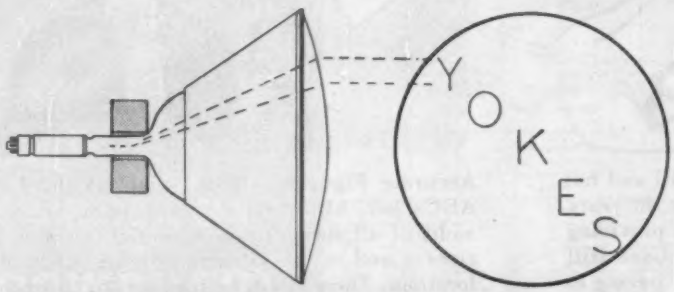

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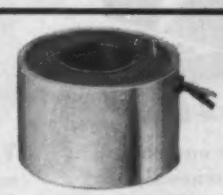
For critical applications, many of our customers have saved years of trial and error in YOKE selection by specifying **Celco** YOKES.

The construction of our yokes makes it possible to achieve **sensitivities, linearities, responses and distortion-free deflecting fields** not possible with the usual types of yoke.

For precision military and commercial displays, Celco also offers standard yokes in **7/8", 1", 1 ⅛", 2", & 2½"** CRT neck diameters.

Write for CELCO DEFLECTION YOKE Catalogue & Design Sheets or for immediate engineering assistance Call your nearest CELCO Plant:



Celco

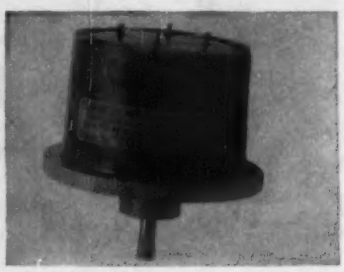
Constantine Engineering Laboratories Co.

Mahwah, N. J.	Miami, Fla.	Cucamonga, Calif.
Davis 7-1123	Plaza 1-9083	Yukon 2-2688

mounting. **Circle 317 on Reader Service Card.**

Rivet Standoff internally threaded

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass., announces production of the Cambion rivet standoff for mounting to terminal boards or panels. The X1246 is available in a variety of shank lengths to accommodate panel thicknesses from 1/32 to ¼ in. and in eight different mounted heights above the board, from ⅛ in. to 1 in. It is internally threaded to enable seating a standard Cambion solder terminal or standard Cambion insulated solder terminal with a threaded mount. Carefully processed from quality brass, each rivet standoff is finished with 0.0003 in. cadmium plate. **Circle 318 on Reader Service Card.**

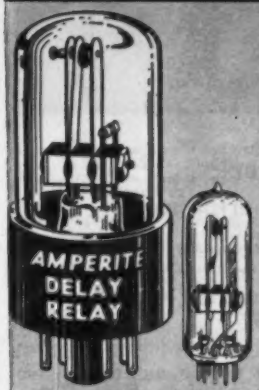


Potentiometer sine/cosine type

CLAROSTAT MFG. CO., INC., Dover, N. H., has available a new sine/cosine potentiometer for use in radar, computer and servomechanism assemblies. Unit has a standard conformity of ± 1 percent peak-to-peak, or a special conformity of ± ½ percent peak-to-peak. It employs oil-impregnated bronze bearings for a recommended maximum speed of 30 rpm. Precise windings,

AMPERITE

THERMOSTATIC
DELAY RELAYS



2 to 180 Seconds

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.

Hermetically sealed. Not affected by altitude, moisture, or climate changes.

SPST only—normally open or closed.

Compensated for ambient temperature changes from —55° to +70° C. Heaters consume approximately 2 W. and may be operated continuously. The units are rugged, explosion-proof, long-lived, and—inexpensive!

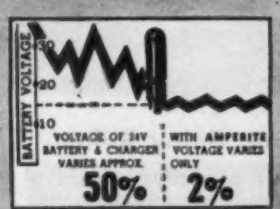
TYPES: Standard Radio Octal, and 9-Pin Miniature . . List Price, $4.00. Standard Delays

Also — Amperite Differential Relays: Used for automatic overload, under-voltage or under-current protection.

PROBLEM? Send for Bulletin No. TR-81

AMPERITE
BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit automatically regulated at a definite value (for example, 0.5 amp.) . . . For currents of 60 ma. to 5 amps. Operate on A.C., D.C., or Pulsating Current.



Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—55° to +90° C.), or humidity . . . Rugged, light, compact, most inexpensive . . . . . List Price, $3.00.

Write for 4-page Technical Bulletin No. AB-51

AMPERITE
561 Broadway, New York 12, N. Y. . . . . CAnal 6-1446
In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

CIRCLE 207 READERS SERVICE CARD

Now...

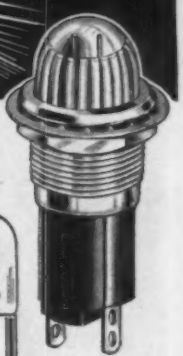
DIALCO Pilot Lights

with Built-in Resistor (18,000 ohms)
(a patented DIALCO feature)

and the NEW High Brightness Neon Glow Lamp NE-51H

A New Advance in Pilot Light Design by DIALCO:

NE-51H


Catalog No. 132-408-991H

Three basic advantages are incorporated in this series of DIALCO assemblies: (1) *Built-in resistor* for direct use on 125 to 250 volt circuits . . . (2) *New plastic lens* designed to give attractive *"halo"* effect . . . (3) New High Brightness Neon Glow Lamp *NE-51H*. This lamp may be operated at about 3 times the level of current that may be applied to the standard lamp, and it will produce 8 times as much light—*with long life!* Very low power is required, less than 1 watt on 250 volt circuit. Recommended for AC service only.

In the DIALCO assembly, the built-in current limiting (ballast) resistor (18,000 ohms) is *completely insulated in moulded bakelite* and sealed in metal (U. S. Patent No. 2,421,321) . . . Small space required—units are available for mounting in 9/16" or 11/16" clearance holes . . . A wide choice of optional features includes lens styles, shapes, and colors; terminal types; metal finishes, etc. . . . Meet applicable *MIL Spec* and *UL* and *CSA* requirements.

All Assemblies Are Available Complete with Lamp

SAMPLES ON REQUEST—AT ONCE—NO CHARGE

DIALIGHT CORP., 58 Stewart Ave., Brooklyn 37, N. Y.

Send brochures on Pilot Lights ☐ for NE-51H Neon lamp ☐ Sub-Miniatures ☐ Oil-Tight

Name ..... Position .....

Company .....

Address .....

Foremost Manufacturer of Pilot Lights

DIALIGHT
CORPORATION

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CIRCLE 208 READERS SERVICE CARD

IN OUTER SPACE, GAS FILLS FOR COUNTER TUBES MUST BE OF HIGHEST PURITY. That's why . . .

EXPLORER'S COSMIC RAY COUNTER TUBE IS FILLED WITH 'LINDE' RARE GASES

On the production line at Anton Electronic Laboratories, Inc., counter tubes are filled with highest-purity LINDE Gases.

A lone cosmic ray detection and measuring tube in the Explorer satellite steadily sends vital information back to Earth. To be absolutely certain this and similar counter tubes perform perfectly, Anton Electronic Laboratories, Inc., subsidiary of U.S. Hoffman, fills them with neon and halogen gas admixtures supplied by LINDE. For these gases, like all LINDE Rare Gases and Mixtures, are the purest obtainable on Earth.

Anton Laboratories uses LINDE Gases exclusively as fills in counter tubes, surgical probe tubes, voltage regulators, and other electronic devices. In mass production, identical tubes filled with LINDE Gases are interchangeable.

For detailed data on physical and electrical properties of LINDE Rare Gases, write Box BD111, LINDE COMPANY, Division of Union Carbide Corporation, 30 E. 42nd St., New York 17, N. Y. Offices in other principal cities. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

Linde TRADE-MARK Ne A Kr He Xe RARE GASES *Symbol of Highest Purity*

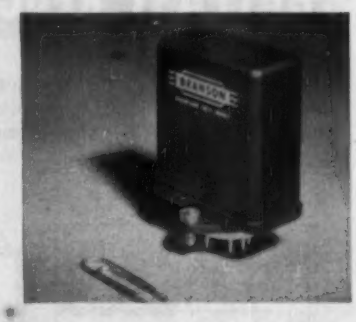
UNION CARBIDE

The terms "Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

plus a low-wear wiper design, results in a guaranteed life of 500,000 cycles. Unit has a flange mount, with a diameter of 2.050 in. and 1.925 in. diameter beyond. Shaft torque is 1.0 oz/in. **Circle 319 on Reader Service Card.**

Receiver high performance

GENERAL ELECTRONIC LABORATORIES, INC., 195 Massachusetts Ave., Cambridge 39, Mass. Type 13A1 receiver has been designed for high performance in the frequency range 55 to 260 mc. Special features include a precision gear drive assembly for motor scan use, easily replaceable 416B and inductance tuning unit for simplified maintenance, plug-in tuning head and an effective pulse agc system. **Circle 320 on Reader Service Card.**

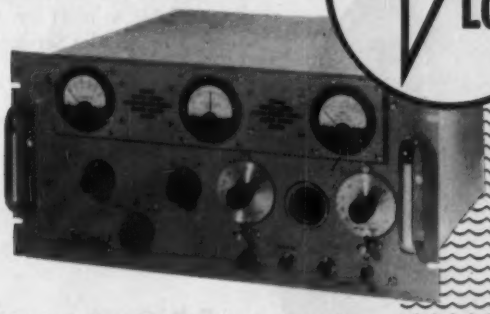


Time Delay Relay spst contacts

BRANSON CORP., 41 So. Jefferson Road, Whippany, N. J. Type MTRH-8 time delay relay features instantaneous recycling and accurate timing, independent of voltage variation, for fixed delays of 15 to 180 sec. Any standard a-c or d-c operating voltage may be used. Contacts are spst either normally open or normally closed and can be supplied to fit various load and life requirements. Unit complies

Latest Addition to NEMS • CLARKE RECEIVER LINE

PHASE LOCK



Now available in the Nems-Clarke line of telemetry receivers is the 1400 Series employing phase-lock detection. The receivers are of the double super-heterodyne type with a noise figure of less than 8 db.

The primary advantages of phase-lock when used as a wide band receiver demodulator is a lowering of the receiver threshold and an overall improvement in signal-to-noise ratio.

Frequency ranges determined by plug in crystals

Type 1420, 1421	215 to 245 mc
Type 1430, 1431	225 to 260 mc
Type 1432, 1433	215 to 260 mc

WORLD'S FOREMOST DESIGNERS AND MANUFACTURERS OF SPECIAL PURPOSE RECEIVERS

NEMS • CLARKE COMPANY

A DIVISION OF VITRO CORPORATION OF AMERICA

919 JESUP-BLAIR DRIVE • SILVER SPRING, MARYLAND • JUNIPER 5-1000

CIRCLE 264 READERS SERVICE CARD

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COSMIC

ELECTROLYTIC & PAPER TUBULAR

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LUdlow 9-3369

Condensers

CIRCLE 265 READERS SERVICE CARD

McGraw-Hill Mailing Lists Will Help You for Results

Mc GRAW-HILL DIRECT MAIL LIST SERVICE

- Merchandise your advertising
- Conduct surveys
- Get inquiries and leads for your salesmen
- Pin-point geographical or functional groups
- Sell Direct
- Build up weak territories
- Aid Dealer relations

Direct Mail is a necessary supplement to a well rounded Business Paper advertising program.
Most progressive companies allocate a portion of their ad budgets to this second medium at the same time as they concentrate on the best business publications.
600,000 of the top buying influences in the fields covered by the McGraw-Hill publications make up our 130 mailing lists. Pick Your prospects out of our Industrial Direct Mail catalogue.

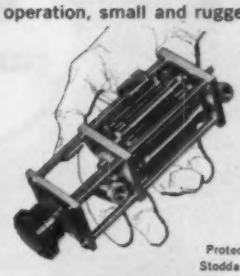
Write for your free copy of our Industrial Direct Mail catalogue with complete information.

STODDART

COAXIAL ATTENUATORS AND TERMINATIONS

made with exclusive Stoddart Filmistors for highly accurate and stable resistive values from dc to 3000 mc.

2, 6 and 10-position
TURRET ATTENUATORS
with simple "PULL-TURN-PUSH" operation, small and rugged.



Protected under Stoddart Patents

ATTENUATOR PADS

Available in any conceivable combination of male and female Type C and Type N connectors. Maximum length of 3" for any attenuation value.

GENERAL SPECIFICATIONS
VSWR: Less than 1.2 to 3000 mc.
Characteristic Impedance: 50 ohms.
Attenuation Value: Any value from 0 db to 60 db including fractional values.
Accuracy: ±0.5 db; values above 50 db have rated accuracy of attenuation through 1000 mc only.
Power Rating: 1.0 watt sine wave.

COAXIAL TERMINATIONS

Small-stable-50 or 70 ohms

½-Watt: 50 ohms impedance, TNC or BNC connectors, dc to 1000 mc, VSWR less than 1.2.

1-Watt: 50 ohms impedance, dc to 3000 mc or dc to 7000 mc, Type N or Type C connectors, male or female; VSWR less than 1.2, 70 ohm, Type N, male or female terminations available.

Fast delivery on all items.
Send for complete literature.

STODDART

AIRCRAFT RADIO CO., INC.
6644 Santa Monica Blvd., Hollywood 38, Calif.
HOllywood 4-9292

CIRCLE 266 READERS SERVICE CARD

. . . on the computer reel

FOR HIGHEST-PRECISION COMPUTER APPLICATIONS . . .

has three important features*

Type EP Audiotape is the extra-precision magnetic instrumentation tape that is guaranteed defect-free. Now EP Audiotape is available in a form particularly suited to electronic computers. It is made on both 1.5-mil cellulose acetate and polyester film. Tapes are 2500 x ½". Every reel is tested by a 7-channel certifier before it leaves the factory and is guaranteed to have absolutely no "dropouts" (microscopic imperfections causing test signal to drop below 50% of average peak output).

* **Reel** is Audio's computer reel – an opaque polystyrene 10½" reel with a hub diameter of 5.125". Each reel comes with pressure-sensitive identification labels and a yellow polyethylene drive slot plug.

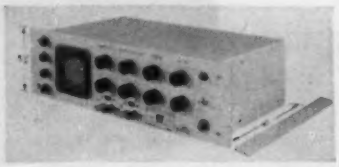
* **Two photo-sensing markers** are accurately placed on the tape, one 14 feet from the hub end, the other ten feet from the other end. These markers are vaporized aluminum sandwiched between the base and low flow thermosetting adhesive. Both markers are firmly placed and wrinkle-free.

* **Container** is of transparent polystyrene and made especially for the computer reel. A center-lock mechanism and peripheral rubber gasket seal the reel from external dust and sharp changes in temperature and humidity.

EP Audiotape on the computer reel has been used in large computer installations with perfect results. Although the reel, markers and container are designed for specific computers, the tape is the same precision EP Audiotape that has stood the tests of time and operation on hundreds of applications in automation, petroleum seismology, telemetering, and electronic computing. To get the complete specifications for type EP Audiotape on the computer reel – or for a Company representative to call – write on your company letterhead to Dept. TE.

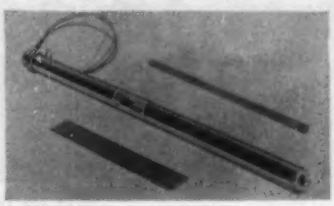
AUDIO DEVICES, INC., 444 Madison Avenue, New York 22, N. Y.

with latest airborne military environmental requirements. It weighs approximately 3 oz and occupies 2.25 cu in. with mounting styles available to meet any need. **Circle 321 on Reader Service Card.**



C-R Oscilloscope compact design

WATERS MFG., INC., Wayland, Mass. Model 7000-B oscilloscope is so compact that it requires no more than a 10 in. depth. A noteworthy feature is that the front panel is not obstructed by leads. Unit is a general purpose instrument and is designed for rack mounting in standard commercial-type racks or cabinets. Frequency response extends from d-c to 100 kc. The horizontal and vertical amplifiers are electrically identical, making the instrument ideal for work in which phase measurements are to be made at various frequencies. Push-pull amplifiers are used throughout. **Circle 322 on Reader Service Card.**



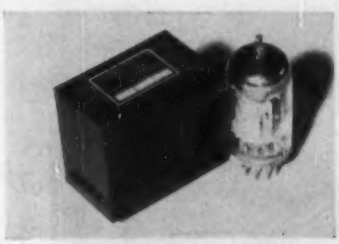
Transformer differential type

SCHAEVITZ ENGINEERING, Route 130 & Schaevitz Blvd., Pennsauken, N. J. Type 3050 XS-AT long travel linear variable differential transformer has a core length of 7.5 in. to 6.3 in., depending on excitation frequency. It is completely enclosed and magnetically shielded. The core is separate from the transformer assembly and is attached by the user to the source of motion. When excited at zero phase fre-

quency of 400 cps the primary to secondary phase shift is substantially zero and the effects of temperature changes are minimized. Nominal excitation range of 50 to 10,000 cps can be extended to 20 kc on special orders. **Circle 323 on Reader Service Card.**

Sub-Zero Cabinet for laboratory use

AMERICAN INSTRUMENT CO., INC., 8030 Georgia Ave., Silver Spring, Md., now offers a newly-modified, dry-ice operated sub-zero cabinet with a temperature range of +200 F down to −120 F. Employed to perform countless diversified tasks in the industrial laboratory, the new sub-zero unit incorporates a large-size testing cabinet in which materials and/or instruments may be tested under prescribed temperature conditions. **Circle 324 on Reader Service Card.**



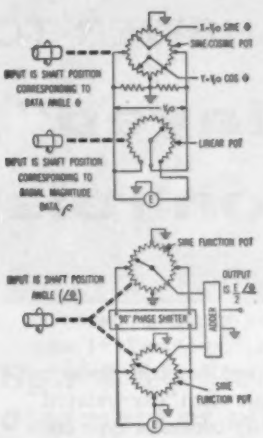
Transistor Circuits in module form

AUTOMATED CONTROLS CO., 1815 Magnolia Road, Alderwood Manor, Washington. The new transistor switching series circuits provide a fully compatible digital logic group which can be assembled in various combinations to perform most logic

SINE-COSINE
Precision
POTENTIOMETER-RESISTORS

For resolution of voltage into sine and cosine components in accordance with positions of shaft rotation.

TYPICAL APPLICATIONS:



ANGLE DATA TRANSMISSION as used in automatic controls, directional and ranging systems, analog computers, and telemetry.

PHASE DIVISION as used in investigation of phase sensitive systems, delay measurements, and timing applications.

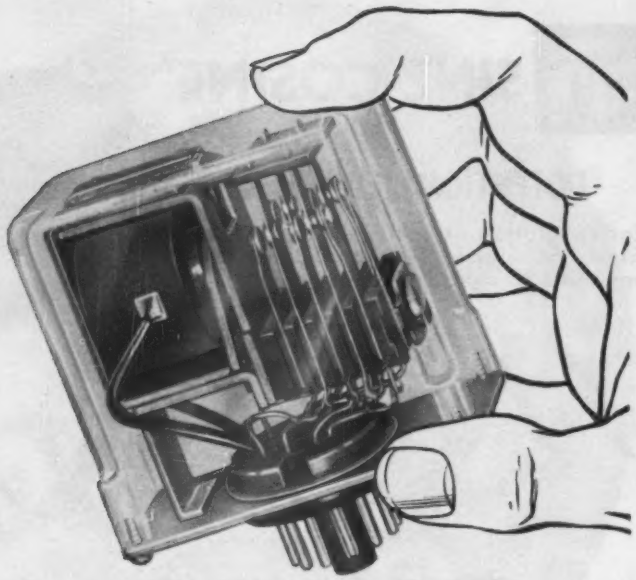
DATA CONVERSION as used in rotation of coordinates, or conversion from polar to rectangular coordinate form, for computers or data display applications.

Potentiometers having sinusoid functions are available in 3", 2", 1⅞", 1½", 1¼", and ⅞" diameters. These potentiometers are available with two sliders giving independent outputs, one proportional to the sine and the other to the cosine of the shaft angle. Multiple units may be ganged and phased for cosine function or for other applications such as rotation of coordinates.

Precision in potentiometer-resistors feature wide temperature range, excellent environmental stability, highly precise mechanical construction and electrical performance.

Technical reports on the use of these units, and complete data are available on request.

TECHNOLOGY INSTRUMENT CORP
569 Main St., Acton, Mass. COlonial 3-7711
P.O. Box 3941, No. Hollywood, Calif. POplar 5-8620



NEW, LOW COST ANSWER TO

"Over-Relayed" Industrial Controls

S-D

FRAME 219 RELAYS

Stock types are DPDT on octal plugs; and DPDT plus two normally-open on 12-pin octal plugs. AC or DC operating coils.

Dimensions are 1 7/16" wide x 2 5/8" deep x 2 7/16" high exclusive of octal plugs.

Smaller, requiring less operating power and reasonably priced, Struthers-Dunn 219 Frame Relays are a big aid to economizing complex industrial panels that are often "over-relayed" with larger, more costly contactor-type control units than are actually needed.

Accepted standards of insulation include spacings of 1/8" through air; 1/4" over surface, and a minimum of 1500 volts AC dielectric test. Other features are long life (20 million operations); plastic covers for good mechanical protection and easy servicing with plug-in construction. Contacts have 10 ampere current carrying capacity. Plug and socket combinations are the limiting factors on ratings.

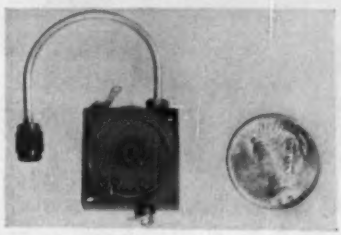
Struthers-Dunn Bulletin 2219 giving full details is available on request.

STRUTHERS-DUNN, Inc.
Pitman, N. J.

Makers of the world's largest selection of relay types

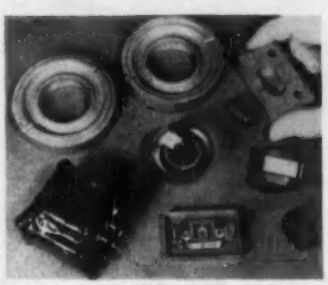
Sales Engineering Offices in: Atlanta • Boston • Buffalo • Chicago • Cincinnati Cleveland • Dallas • Dayton • Detroit • Kansas City • Los Angeles • Montreal • New Orleans • New York • Pittsburgh • St. Louis • San Francisco • Seattle • Toronto

system operations. Current handling capabilities to 2 amperes permit direct connection to power equipment. The circuits are epoxy resin encapsulated within Nylon cases for maximum reliability and environmental resistance. A simplified snap-in mounting arrangement provides a low resistance thermal path to the chassis. **Circle 325 on Reader Service Card.**



Pressure Switch light weight

HALAX CORP., 17470 Shelbourne Way, Los Gatos, Calif., announces a pressure switch manufactured from magnesium and aluminum to provide a light weight component for aircraft application. It weighs only 1¼ oz, will operate up to a 60 lb psig with ± 1 psig of its setting. This pressure switch is generally used in warning devices such as fuel warning on aircraft and pressure warning devices in airborne radar. **Circle 326 on Reader Service Card.**



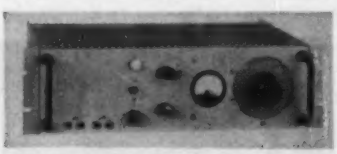
Epoxy Resins longer pot life

MITCHELL-RAND MFG. CORP., 51 Murray St., New York 7, N. Y., is marketing a new line of potting formulations, based on epoxy resins and using Hexahydrophthalic Anhydride or Methyl Nadic Anhydride

as the curing agent. These curing agents have a lower volatility at elevated temperatures than amine curing agents frequently used. Another advantage of these compounds is that their pot life is longer, in some cases as much as one week. This permits higher production and means less waste. **Circle 327 on Reader Service Card.**

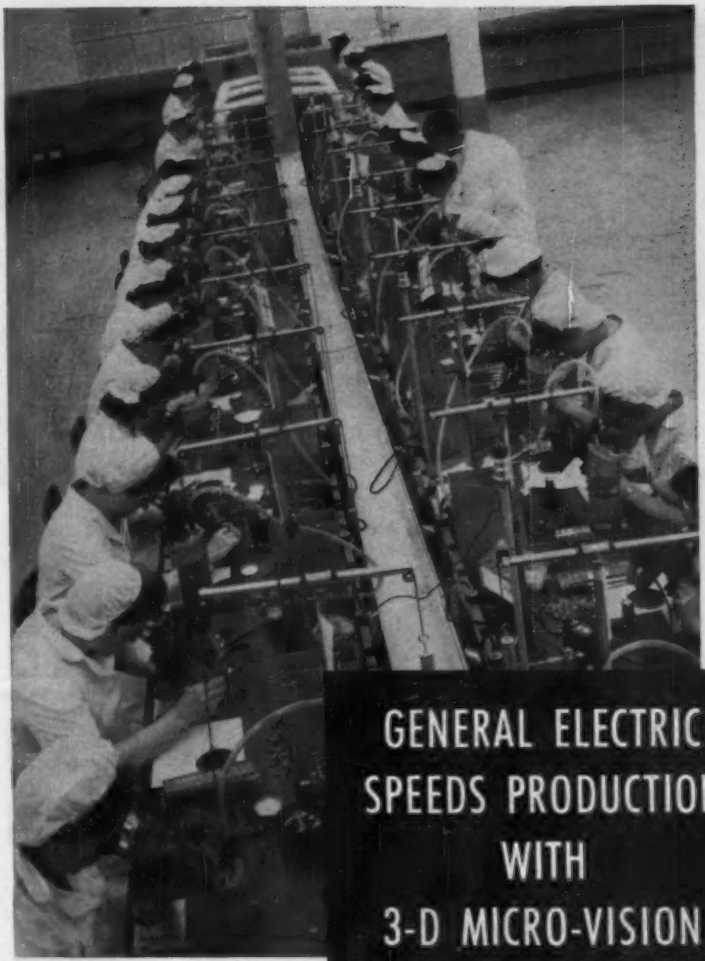
Blower Motor 400 cycle unit

WESTERN GEAR CORP., Electro Products Div., 132 W. Colorado St., Pasadena 1, Calif. Model 65JG1 is a 27 v a-c, 3 phase, 400 cycle blower motor qualified to meet MIL-M-13787 Signal Corps specifications. The motor which measures only 1.07 in. in diameter and 1.32 in. in length, produces 0.2 oz-in. of torque at 10,200 rpm. It is designed for continuous duty at 87 C with a life of 1,000 hr. Unit weighs 3 oz. **Circle 328 on Reader Service Card.**



Power Supply for military use

POWER SOURCES, INC., Burlington, Mass. Model PS4004 semiconductor power supply is a military version of the PS4000A. Nominal input voltage of 105-125 v a-c, 50-63 cps, selected by a front panel switch, may be varied as specified in MIL-E-4158A. Output voltages range from 260-300 or 130-150 v dc. Output impedance is less than 0.1 ohm from d-c to 100 kc. Stabilization is less than ±0.05 v on



How B&L Stereomicroscopes help in assembly of ultra-precision transistors

These skilled operators are doing a job that "just couldn't be done without stereomicroscopes," according to Norman Spoonley, foreman, Semiconductor Products Dept., General Electric Co., Buffalo. This critical phase of transistor assembly involves soldering a 1-mil nickel wire between a nickel tab and the .6-mil core of a .1" germanium pellet which, in turn, is fused between two 5-mil nickel wires. B&L Stereomicroscopes make it possible by showing enlarged views in natural 3D. Air-tight, dust-free design keeps images sharp, clear, undistorted . . . for full-working-day efficiency without visual fatigue. In assembly, quality control, inspection, some 100 B&L microscopes help G. E. mass-produce to highest precision standards. If you have small-parts assembly and inspection problems, you need B&L Stereomicroscopes.

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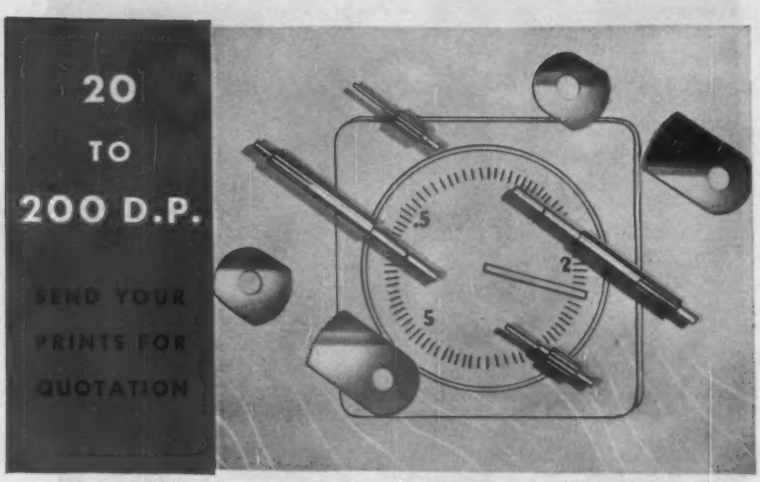
☐ I'd like to borrow a B&L Stereomicroscope for 15-day trial without cost or obligation.
☐ Send me Stereomicroscope Catalog D-15.
Name .....
Title .....
Company .....
Address .....
.....



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LEAD SCREWS • RATCHETS • CLUSTER GEARS • RACKS • INTERNALS • ODD SHAPES

THE *Finest* IN GEARS •

Beaver Gear Works Inc.

1021 PARMELE STREET, ROCKFORD, ILLINOIS

CIRCLE 214 READERS SERVICE CARD

Now...

POSITIVE ACTION SWITCHES

- Wiping contacts insure perfect switching for very low energy circuits
- Positive-break action insures safe, reliable switching with high energy circuits
- Direct toggle-to-contact mechanism guarantees switching action
- First totally enclosed, environment proof toggle switch
- 1° lever throw opens circuit
- Positive detent action prevents switch teasing
- New insulating material gives 3 times greater arc tracking resistance
- Greater terminal clearance for easier wiring
- Improved bushing seal is molded in place

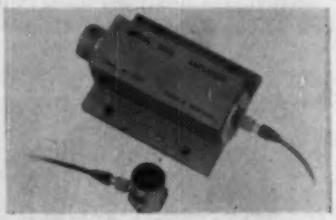
Cutler-Hammer single, double, and four pole Positive Action Switches will be available in unlimited circuit arrangements . . . single throw, double throw, momentaries, etc. For detailed information, write for Pub. EA-168-W220, CUTLER-HAMMER Inc., Milwaukee 1, Wisconsin.

CUTLER-HAMMER CONTROL C-H

CUTLER-HAMMER

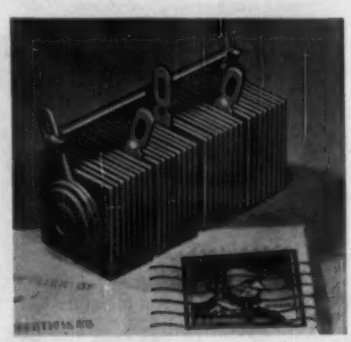
Cutler-Hammer Inc., Milwaukee, Wis., Division: Airborne Instruments Laboratory. Foreign: Cutler-Hammer International, C. A. Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation, Inc.

300 v output, and less than ±0.025 v on 150 v output. Ripple and noise averages less than 1.0 mv, and drift is less than 0.02 v after half-hour warm up. **Circle 329 on Reader Service Card.**



Tiny Amplifier for airborne use

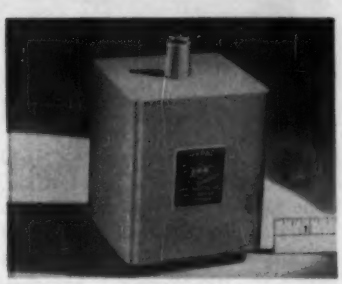
ENDEVCO CORP., 161 E. California St., Pasadena, Calif., offers a subminiature a-c instrument amplifier, model 2618, to satisfy latest requirements of missile telemetry and general airborne use. Designed for application with Endevco piezoelectric accelerometers, the new amplifier provides variable gain, 6 to 20. It is completely sealed and will operate continuously in ambients of 250 F under normal flight vibration and shock. Fully compensating feedback reduces harmonic distortion and nonlinearity to less than 1 percent with a gain stability of ± 1 percent. The amplifier withstands vibration and shock to 100 g's without shockmount. **Circle 330 on Reader Service Card.**



Miniature Rectifier single phase

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. A new single phase bridge rectifier with a maximum input

voltage of 260 v rms is designed for connection directly to a 230 v line . . . thus eliminating the need of using the step-down transformer usually employed with 130 v rms rectifiers. Unit is rated to supply 100 ma output into a resistive load, with a d-c output voltage of approximately 180 v into a resistive or inductive load. Type 61-4037 rectifier has an overall volume of only 1.31 cu in. **Circle 331 on Reader Service Card.**



Power Packs miniaturized

ERA Pacific, Inc., 1760 Stanford St., Santa Monica, Calif. New developments in advanced transistor circuitry have made possible high-voltage, regulated semiconductor power packs which are free from limitations of previously available types. The Hypac line provide output voltages in the range of 1,000-10,000 v d-c with current ratings in the milliampere range. Units are intended for all types of applications, including c-r indicators, klystrons, twt's, microwave equipment powering, Geiger, scintillation counters, and dielectric testing. **Circle 332 on Reader Service Card.**

D-C Amplifier wide-band unit

Computer Engineering Associates, Inc., 350 North Halstead, Pasadena, Calif., announces a new high-current, high-voltage, wide-band d-c amplifier. It is designed for applications requiring a differential, isolated or grounded amplifier and is available in six amplifier models or as single packaged units. It is engineered for use in any system requiring amplification of

look what $24.50 buys in test equipment!

HEATHKITS GIVE YOU TWICE AS MUCH equipment for every dollar invested

The famous model V-7A Vacuum-Tube-Voltmeter is a perfect example of the high-quality instruments available from Heath at ½ the price you would expect to pay! Complete, only $24.50

Get the most out of your test equipment budget by utilizing HEATHKIT instruments in your laboratory or on your production line. Get high quality equipment, without paying the usual premium price, by dealing directly with the manufacturer, and by letting engineers or technicians assemble Heathkits between rush periods. Comprehensive instructions insure minimum construction time. You'll get more equipment for the same investment, and be able to fill your needs by choosing from the more than 100 different electronic kits by Heath. These are the most popular "do-it-yourself" kits in the world, so why not investigate their possibilities in your particular area of activity! Write for the free Heathkit catalog now!

Contains detailed descriptions of Heathkit models available, including VTVM's, scopes, generators, testers, bridges, power supplies, etc.

Also describes Heathkit ham gear and hi-fi equipment in kit form. 100 interesting and profitable "do-it-yourself" projects!

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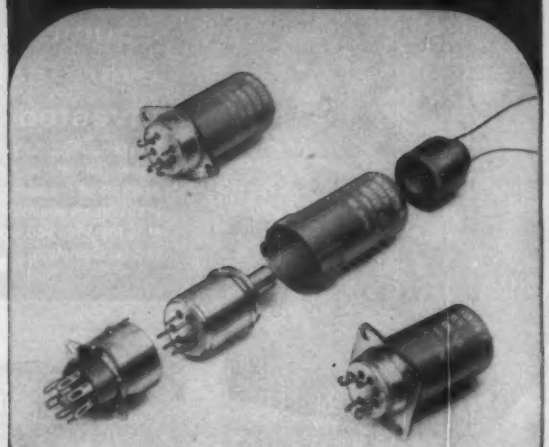
State _____

THESE LOW-NOISE CHOPPERS



BRISTOL MINIATURE SYNCROVERTER CHOPPERS

ARE NOT NEW!

Proven reliability: for years, Bristol's external coil SYNCROVERTER® choppers have exhibited their extremely low noise and long life characteristics in the most stringent of applications.

For complete specifications, write The Bristol Company, 150 Bristol Road, Waterbury 20, Connecticut.

BRISTOL

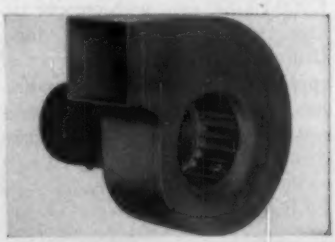
FINE PRECISION INSTRUMENTS FOR OVER 68 YEARS

signals from d-c to 50 kc. Bulletin AI 132.1 describes it in detail. **Circle 333 on Reader Service Card.**

Digital Voltmeter

a-c/d-c

ELECTRO INSTRUMENTS, INC., 3540 Aero Court, San Diego 11, Calif. The DVA-410 a-c/d-c digital voltmeter features totally transistorized circuits and internal and external modular construction. Measurements are automatically made to four digits and displayed on an edge-lighted readout. A-C polarity symbols and ranging are automatic. A-C accuracy is 0.1 percent or two digits. D-C accuracy is better than ±1 digit. Range is 0.0001 to 999.9 v. Average readout time is only three seconds. **Circle 334 on Reader Service Card.**

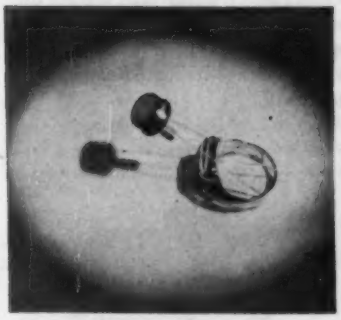


Cooling Blowers

large flow range

THE TORRINGTON MFG. CO., Torrington, Conn., announces high-efficiency, low-pressure centrifugal blowers in a complete series from 2-in. to 9-in. diameters. They are designed specifically for cooling electronic equipment in aircraft, missiles, radio and computer service. Range of air delivery is from 20 to 2,000 cfm, depending upon the impeller size and motor speed. Input power is provided by either

a-c, d-c or 400-cycle aircraft motors. Total weight of the unit is less than 2 lb. **Circle 335 on Reader Service Card.**



Silicon Transistors

intermediate power

TEXAS INSTRUMENTS INC., P.O. Box 312, Dallas, Texas. Four new *npn* intermediate power silicon transistors, made by the gaseous diffusion process, feature 40 w dissipation at 25 C, 500 ma maximum collector current and a low 15 ohms maximum saturation resistance. For maximum design ease, beta spreads of 12- to -36 or 30-to-90 are available in either the 120-v 2N1048 and 2N1050 or the 80-v 2N1047 and 2N1049. Internal design permits mounting the semiconductor wafer directly to the stud, providing excellent heat transfer characteristics. **Circle 336 on Reader Service Card.**

Oscillator-Mixer

four functions

DATA-CONTROL SYSTEMS, INC., Danbury, Conn. A new reference oscillator-mixer, model GRO-2, combines four functions. The unit, for use in tape speed compensation in f-m data systems, (1) generates a reference frequency for addition to an f-m/f-m telemetering multiplex, (2) mixes the reference fre-

300 TIMES GREATER SENSITIVITY

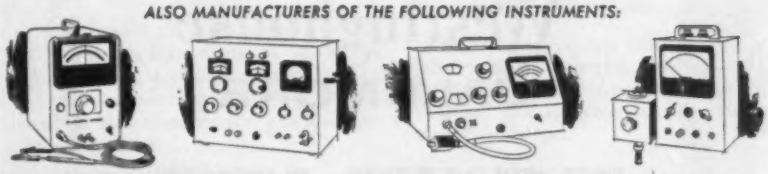
THAN CONVENTIONAL RF VOLTMETERS

from 50 KC to 600 MC

MODEL 91-CA
300 microvolts to 3 volts
Price: $495

MODEL 91-C
1000 microvolts to 3 volts
Price: $395

ALSO MANUFACTURERS OF THE FOLLOWING INSTRUMENTS:



DC Millivoltmeter | Capacitance Bridge | RF Distortion Meter | UHF Grid Dip Meter

Boonton ELECTRONICS Corp.

Morris Plains, N. J. • Phone: JEfferson 9-4210

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Symbol of Engineering Leadership

Wherever the barriers to scientific progress are being broken . . . wherever man is carving the new dimensions of the future . . . there you'll find the Westinghouse seal. In Baltimore, where Westinghouse is making electronics history, the famous W is your symbol of engineering opportunity. Forward-looking engineers are finding the careers of tomorrow at Westinghouse-Baltimore today. Won't you join them?

A PARTIAL LIST OF CURRENT OPENINGS

Digital-Analogue Computer Design, Transistor Circuitry, UHF Communications, Insulation, Electronics Circuitry, Intermediate Frequency Amplifiers, Microwave Components, Network Synthesis, Engineering Writing.

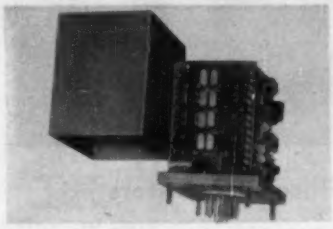
WRITE TODAY TO:

Dr. J. A. Medwin, Dept. 839, Westinghouse Electric Corporation, P. O. Box 746, Baltimore 3, Maryland.

Westinghouse
BALTIMORE

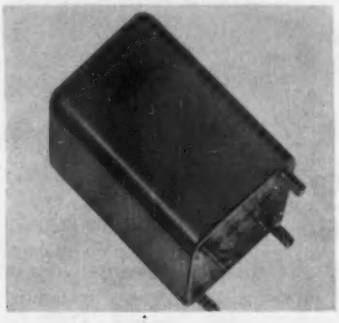
FIRST WITH THE FUTURE . . . IN ENGINEERING

quency and the multiplex, (3) de-emphasizes the multiplex spectrum for recording and (4) matches reference and signal amplitudes. The oscillator-mixer incorporates a plug-in frequency unit which adapts the unit to any desired reference frequency up to 100 kc or to tape speed. **Circle 337 on Reader Service Card.**



A-F Standard weighs only 11 oz.

Reeves-Hoffman Division of Dynamics Corp. of America, Carlisle, Pa. Stability at high shock and vibration is a feature of the TCO/300-OC audio-frequency standard. This transistorized crystal oscillator with oven control can withstand shock up to 100 g's or vibration from 0 to 2,000 cps at 10 g's. Frequency range is 400 to 2,000 cps. Frequency stability is ± 0.002 percent over a temperature range from −55 to +85 C. Output is of the square-wave type. The unit will meet applicable portions of MIL-E-5272A. **Circle 338 on Reader Service Card.**



Power Transformer for airborne use

Communication Accessories Co., Lee's Summit, Mo. Hermetically sealed, built per MIL-T-27A,

Instant Reset, Voltage Compensated THERMAL TIME DELAY RELAYS "IR" and "STR" Series for military applications

- Vibration resistant — withstand 5-500 cps
- Ambient temperature —65°C. to +125°C.
- Time delays — up to 180 seconds
- Small size — miniature

The "IR" and "STR" relays are part of the Curtiss-Wright Thermal Time Delay Relay line which includes:

H-Series
— vibration resistant, for missiles, aircraft

S-Snapper
— double-throw, snap-action contacts

MR and CR
— double-throw, fast reset, no chatter

K, G and W
— economical, low-cost, stocked

For our new catalog, write or phone Electronics Division, Components Dept., Carlstadt, New Jersey, GEneva 8-4000.

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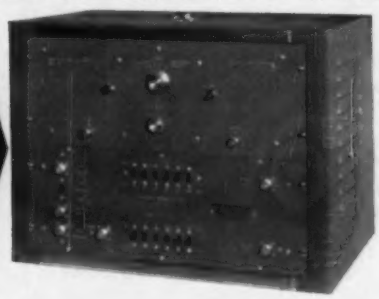
CORPORATION • CARLSTADT, N. J.

CIRCLE 220 READERS SERVICE CARD

FOR 3mμs RISE TIME WITH STANDARD OSCILLOSCOPES



SKL's 320 mc bandwidth Model 206 distributed amplifier serves to achieve 3 mμs rise time performance with various oscilloscope models now in common use.

Employing the Model 206 as the vertical amplifier of the scope, the application is accomplished by connection of a Series 200-28 Adapter directly to the CRT deflection plates and insertion into the circuit of the Model 200-32 Signal Control Panel. The amplifier and panel are packaged in a convenient, compact rack arrangement.

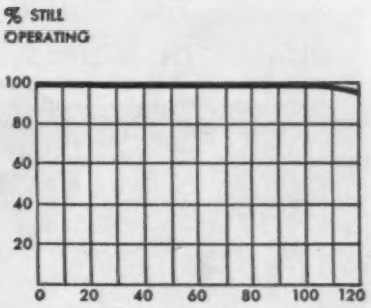
Quickly and easily made, the modification provides an economical solution to the widely increasing requirement for very fast rise time displays. When the application is not in use, a cut-out switch on the adapter unit permits reversion to normal operation, so that all the other functions of the general purpose oscilloscope are retained.

- GIVES HIGH SPEED SCOPE PERFORMANCE AT MODERATE COST
- QUICK, SIMPLE ATTACHMENT
- SWITCH CONTROL FOR MODIFIED OR NORMAL OPERATION

For full information, write to:

SKL SPENCER-KENNEDY LABORATORIES, INC.
1320 SOLDIERS FIELD ROAD
BOSTON 35, MASS.

CIRCLE 221 READERS SERVICE CARD



If you want reliable transformers

..don't overlook this old solution

Right now, you demand more from transformers than ever before. You must have high reliability, even at extreme altitudes, and you need smaller lighter units.

Used, and *proved*, for decades, oil-encased transformers should not be forgotten in a search for new methods.

Everyone knows the advantages: effective convection of heat, excellent insulating properties, complete insurance against hidden leaks. Oil-*sealed* types (with a nitrogen bubble) are good, light, high-altitude transformers. Gas-free oil-*filled* types (with a bellows to allow for heat expansion) withstand very high voltage stresses. Except in the smallest sizes, they save space, too.

You can place several high voltage units close together in a single oil-filled case, and save case weight. Those connections moved inside the case no longer need large insulators. Even the units themselves can be smaller. This all adds up—particularly in high altitude service—to interesting savings in space and weight.

We make all sorts of transformers and special assemblies for the communication industry: encapsulated, cast in epoxy or foam, and just potted in pitch. But oil transformers still have an important place.

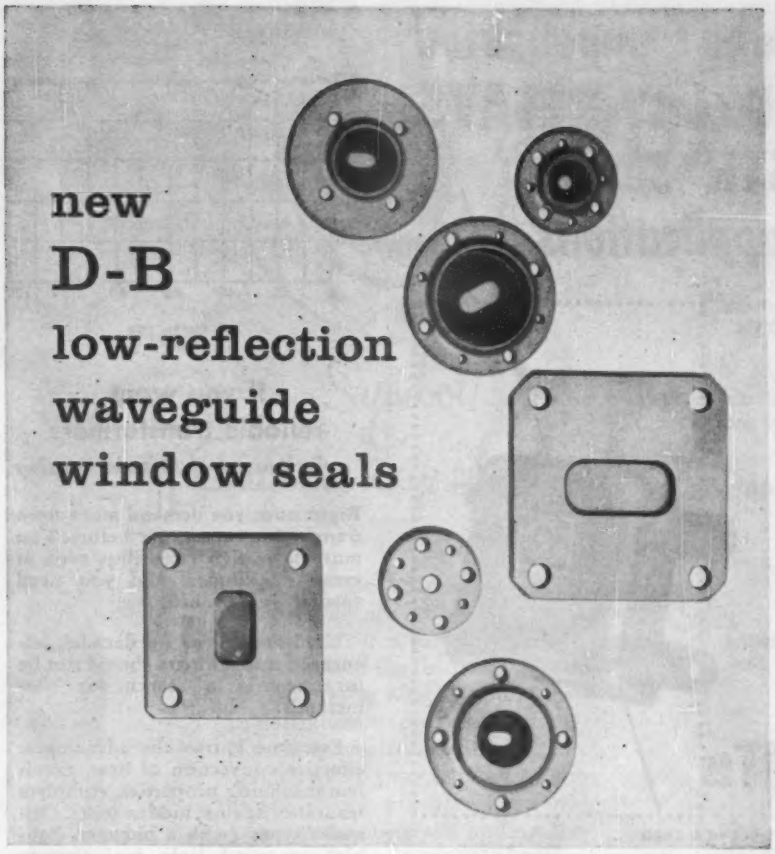
Whatever type you need, we'll be glad to hear from you. Our facilities in design, production, and quality control are at your service. Our experience, too.

CALEDONIA
ELECTRONICS AND TRANSFORMER CORPORATION

Dept. E-11, Caledonia, N.Y.

In Canada: Hackbusch Electronics, Ltd.
23 Primrose Ave., Toronto 4, Ontario

CIRCLE 222 READERS SERVICE CARD



These rugged hermetic seals pass microwave energy with minimum reflection loss. Soldered directly to the waveguide flange, they seal out moisture, dust, oil, and salt spray—or maintain constant pressure or constant dielectric inside.

Thermally stable. D-B seals will not fracture in desert or arctic climates . . . will withstand degassing by baking. Units are vacuum-tight . . . shock and vibration proof. Seven standard sizes cover the entire microwave and ultra-microwave range.

Write for complete data.

specifications

Type Windows: Metal-glass-mica, optically clear.

Size Range: 7 standard sizes cover from 8.2 to 90 KMc.

Temperature range: —55°C to +100°C.

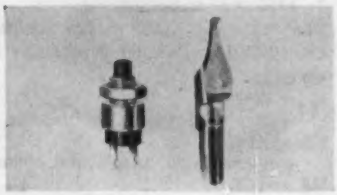
VSWR: Averages 1.19 over entire range.

Pressure Differential: 30 psi.

DE MORNAY BONARDI

DEMORNAY-BONARDI • 780 SOUTH ARROYO PARKWAY • PASADENA, CALIFORNIA

Grade 4, Class S specifications, the new transformers have a maximum operating altitude of 70,000 ft. They were designed for equipment using transistors or a combination of transistors and vacuum tubes, incorporating all primaries 115 v, 380 to 1,200 cps. The transformers are ideal for aircraft communication and navigation equipment. **Circle 339 Reader Service Card.**



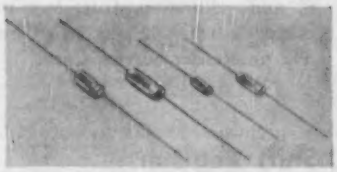
Push Button Switch normally closed

GRAYHILL, INC., 561 Hillgrove Ave., La Grange, Ill., announces a new normally closed spst subminiature push button switch. Overall length, including solder type terminals, is 0.97 in.; maximum diameter, 0.37 in. The No. 30-2 switch is conservatively rated at 100 ma with a life expectancy of over 1,000,000 operations, and features fine silver contacts. Button caps in 10 different colors are available as an accessory. **Circle 340 on Reader Service Card.**

R-F Voltmeter switch controlled

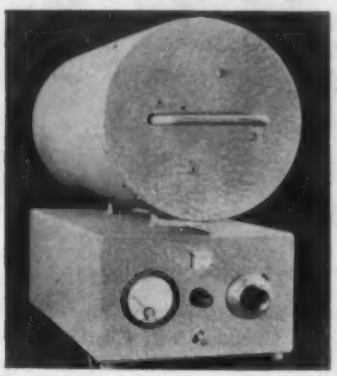
SENSITIVE RESEARCH INSTRUMENT CORP., 310 Main St., New Rochelle N. Y. Model RFV radio-frequency voltmeter is a true rms responding, direct-reading unit for the precision checking and calibration of oscillators, signal generators, electronic voltmeters and

similar apparatus or as an a-c/d-c transfer standard. Accuracy is 0.5 percent of full scale. **Circle 341 on Reader Service Card.**



Tantalum Capacitors sintered-anode

SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass., has announced improved tubular-case sintered-anode tantalum capacitors. Type 109D design not only has better performance characteristics with regard to low temperature, impedance at higher frequencies, and life test duration, but also can be furnished with insulating sleeves resulting in appreciable space saving in many designs. It does not require the cutting of chassis slots to accommodate the shoulder in order to minimize the effective volume the capacitor occupies. Technical data are contained in bulletin 3700B available on letterhead request.



Test Oven high-stability unit

AIRTRONICS, INC., Bethesda, Md. A new variable temperature oven can be used to test and process high-stability quartz crystal units; to calibrate thermometers, bolo-

FROM BENDIX RED BANK—
SUBMINIATURE XENON TETRODE THYRATRON

RETMA 5643

IMPROVED TYPE TD-17

MECHANICAL DATA

Base . . . Button: Subminiature 8-pin long or short leads	
Envelope	T-3 (8-1)
Bulb Length (Max.)	1.375 in.
Diameter (Max.)	0.400 in.
Mounting Position	Any
Altitude Rating (Max.)	60,000 ft.
Bulb Temperature (Max.)	125°C.
Ambient Temperature (Min.)	—55°C.
Cathode	Coated Unipotential

ELECTRICAL RATINGS

Heater Voltage	6.3 Volts
Heater Current	0.15 Amperes
Peak Plate Inverse Voltage	500 Volts
Peak Forward Plate Voltage	500 Volts
Maximum Negative Grid 1 Voltage	—200 Volts
Maximum Negative Grid 2 Voltage	—100 Volts
Maximum Average Cathode Current	16 mAdc
Maximum Peak Cathode Current	100 mA
Heater-Cathode Voltage: Maximum	+25 Vdc
	—100 Vdc
Cathode Warm-up Time	10 sec.

APPLICATIONS: Counters, grid control rectifiers, gyro erection systems, missile systems, automatic flight control systems, and other control circuits requiring utmost degree of reliability.

ADVANTAGES: Freedom from early failure . . . long service life . . . uniform operating characteristics . . . ability to withstand severe shock and vibration.

FEATURES: Advanced mechanical and electrical design plus 100% microscopic inspection during manufacture . . . special heater-cathode construction minimizes shorts . . . 24-hour run-in tests under typical overload conditions.

The TD-17 is but one of many electron tubes designed and built by Bendix Red Bank for special-purpose applications. For full information on the TD-17, or on other tubes for other uses, write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

West Coast Office: 117 E. Providencia Ave., Burbank, Calif.
Canadian Distributor: Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ontario
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Red Bank Division — Bendix AVIATION CORPORATION

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HICKORY BRAND
ELECTRONIC WIRES
and CABLES
• QUALITY ENGINEERED
• PRECISION MANUFACTURED
• PLASTIC INSULATED AND SHEATHED

MW HOOKUP WIRE

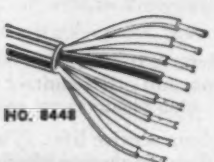
Use for electronic devices, aircraft instruments, radio and radar transmitters, receivers, lighting and power rectifiers. Thirty color combinations. Features high dielectric strength, resistance to acids, alkalies, oil, flame and moisture. Fungus-proof. Temperature rating minus 40° to 80° C.

NO. 8529 (MW-C-20-(1)-U)
NO. 8522 (MW-C-18-(16)-U)

INTERCOMMUNICATING and SOUND SYSTEM CABLES

Shielded and unshielded cables available, also composite types. Designed for long service life, excellent mechanical and electrical characteristics. Use for balanced intercom systems, annunciators, telephones, control circuit cable, electronic computer cable, multiple speaker and signal systems.

NO. 8735



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COAXIAL CABLES

Maximum operating efficiency in applications requiring high, very high and ultra-high frequencies.

RG-58/U

RG-59A/U

RG-17A/U

HOOKUP and LEAD WIRES

Use for high voltage leads to cathode ray tubes. Features high dielectric strength, corona resistance and minimum surface leakage.

NO. 8869
NO. 8868

Write for complete information on the full line of HICKORY BRAND Electronic Wires and Cables

HICKORY BRAND
Electronic Wires and Cables

Manufactured by
SUPERIOR CABLE CORPORATION, Hickory, North Carolina

3504

meters, and thermocouples; and to test small electronic components. The oven controller is all electronic, employing transistors and hermetically sealed components. Temperature range of the standard oven is 30 C to 300 C. Stability is +0.005 C and calibration drift does not exceed +0.003 C per day. **Circle 342 on Reader Service Card.**

Shift Register
two-core-per-bit

AIRTRONICS, INC., 5522 Dorsey Lane, Bethesda, Md. The DK101-T is a two-core-per-bit shift register designed for use with a transistor driver. It features a nominal drive current which has been raised from 100 ma to 300 ma to match transistor capabilities. The resulting 3 to 1 reduction in reactive voltage developed across the drive winding permits three times as many units to be driven in a series string. **Circle 343 on Reader Service Card.**

Battery Holders
three new models

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass., has available three new clips designed to grip batteries under the most severe conditions of shock and vibration. They mount directly to the chassis or printed circuit board. A spring loaded end accommodates the production tolerances of the mercury cell and allows insertion of the cell in tight spots no longer than the holder

Hycon

MODEL 645AR

DIGITAL VOLT-OHMMETERS

combine readability with reliability and accuracy

For your laboratory, incoming inspection, or in-line test positions—or wherever *accurate* and *reliable* measurements must be made *quickly*—you need a HYCON Digital Volt-Ohmmeter.

READABLE ½" digits, in line, with illuminated decimal point and polarity indicator for fast (2 second average) readout without interpolation error.

RUGGED AND RELIABLE with no delicate components—designed for continuous operation, and to withstand shock and vibration without loss of accuracy.

Complete Data in Bulletin 645

Model 645AR 0.1% accurate, DC and Ohms..... **$875.00**

Model 615AR 0.5% accurate, DC and Ohms..... **$485.00**

Both instruments are 1% accurate on AC from 10 to 1000 volts; 2% accurate below 10 volts.

3 DIGITAL INSTRUMENTS IN 1

The HYCON reads DC volts in 4 decimal ranges from .001 V to 999 V...AC volts in 3 decimal ranges from 1.0 V to 999 V RMS...resistance in 5 decimal ranges from 1 ohm to 9.99 megohms.

High impedance (vacuum tube) input. Size 5¼ x 19", 11" deep. Complete with probes.

Hycon ELECTRONICS, INC.

A SUBSIDIARY OF HYCON MFG. CO.

370 South Fair Oaks, Pasadena, California

Order from your HYCON representative, or from:

CIRCLE 226 READERS SERVICE CARD

GREEN *Pantograph Engravers*

ELIMINATE DELAYS!

Keep the work in your own plant

PORTABLE 40-POUND BENCH-MODEL 106

Famous 2 or 3-dimensional engraver, successfully used by thousands, features 5 positive, accurate pantograph ratios. Versatile ball bearing spindle has three speeds up to 14,000 rpm; height of pantograph and position of cutter are continuously adjustable; one copy carrier (supplied) accepts all standard master type sizes.

The Model 106 has proven incomparable for speed and accuracy . . . yet reasonably priced.

Cutter grinders, rotary tables, master letters, compound slides, name plates and all required accessories. For complete information, write to

MODEL D2 HEAVY-DUTY 2-DIMENSIONAL

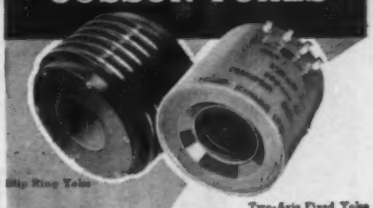
- 975 pounds — rigid, sturdy, precise
- Vertical adjustment of copy table automatic with Pantograph
- Unobstructed on three sides to take large work
- Micrometer adjustment for depth of cut
- Ball-bearing construction throughout — super-precision ball bearing spindle
- Spindle speeds up to 26,000 rpm for engraving or machining modern materials
- Ratios 2 to 1 to infinity — master copy area 26" x 10"
- Vertical range over 10"

GREEN INSTRUMENT COMPANY, INC.

363 PUTNAM AVENUE, CAMBRIDGE 39, MASS.

CIRCLE 227 READERS SERVICE CARD

PRECISION DEFLECTION WITH COSSOR YOKES



Slip Ring Yoke

Two-Axis Fixed Yoke

Component Development Engineering at its BEST!

- ADVANCED ELECTRICAL DESIGN
- PRECISION MECHANICAL DESIGN
- ACCURATE PRODUCTION METHODS

Custom Built to the most Exacting Specifications by Cossor Engineers

In Mumetal Cores for Optimum Geometry
In Ferrite Cores for Speed and Sensitivity
In Non-magnetic Cores for Perfection of Response

Any of Cossor's Three Core Types can be made in single or double axis with single or push-pull windings, and encapsulated for fixed or slip ring (rotating) use.

Normal characteristics of yokes for 1-1/2 in. neck tubes are:

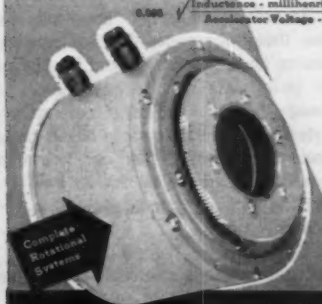
Positional accuracy - the spot position will conform to the yoke current co-ordinates within 0.25% of tube diameter. For deflection angles less than ± 25° better accuracy can easily be achieved.

Memory - 0.5% max. without overswing: 0.1% or less with controlled overswing.

Complete encapsulation in epoxy (stycast) or silicone resins is standard for all Cossor deflection yokes, and is done with special moulding tools ensuring accurate alignment of the yoke axis. When slip rings are added, solid silver rings are mounted in encapsulating resin. The finished slip ring yoke is precision turned to centre bore, and can include bearing mounting surfaces with dimensional tolerances approaching those associable with high quality metal parts.

Settling Time (Micro sec.) = $\frac{}{120 \sqrt{\text{Inductance in Henries}}}$

Sensitivity degrees/milliampere = $\frac{}{0.585 \sqrt{\frac{\text{Inductance - millihenries}}{\text{Accelerator Voltage - kV}}}}$



Complete Rotational Systems

COMPONENTS DIVISION

COSSOR CANADA LIMITED

301 Windsor St., Halifax, N. S.
8230 Mayrand St., Montreal, Que.
648A Yonge St., Toronto, Ont.
Corporation House, 160 Laurier West, Ottawa, Ont.

CIRCLE 228 READERS SERVICE CARD

another first from UNIVERSAL

now,

GREATER RELIABILITY!

Transistorized C. & N. Power Supplies
PROTECTED Against SPIKES & TRANSIENTS*

*as encountered in air-ground systems per MIL E 7894A

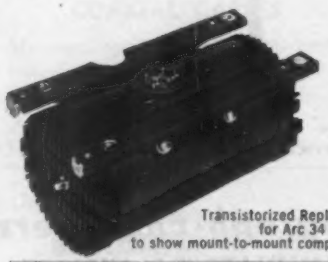
The pioneer in transistorized circuitry for power supply applications now puts you a tremendous step ahead in the design of truly reliable missile and aircraft systems. Universal's intensive research toward total protection against the hazards encountered in these systems results in a notable achievement!

Advanced circuitry now provides built-in protection against spikes and transients which disturb the system voltage. Coupled with the well-known reliability of the Universal static supplies now powering much of today's operational mobile electronic equipment, these units set a new standard for the field. They retain Universal's superior protection against input polarity reversal and against short circuits while providing you with unmatched overvoltage control, as well. Clearly, Universal has the experience to supply the reliable power needed for your most critical applications.

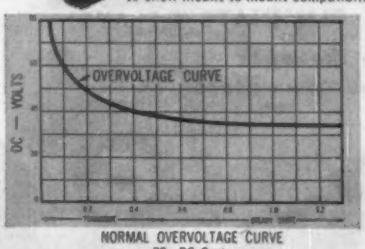
For many other types of power supplies, too, Universal provides the most complete source for designers who want the highest in performance and the most modern in design. Special circuitry, conservatively rated, results in their specifications being met—and surpassed! You can look with confidence, to Universal for:

- DC to DC
- AC to DC
- DC to AC
- High Voltage
- Low Voltage
- High Power
- Low Power

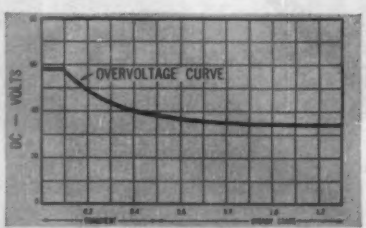
Or custom units to meet wide temperature range and rugged shock specifications.



Transistorized Replacement for Arc 34 inverted to show mount-to-mount compatibility



NORMAL OVERVOLTAGE CURVE
—28v DC System



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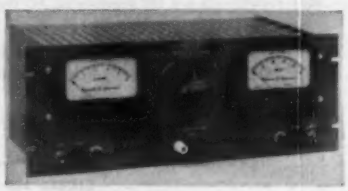
IN CANADA—Conway Electronic Enterprises Regd., 1514 Eglington Ave., Toronto 10, Ont., Canada

itself. **Circle 344 on Reader Service Card.**

Time Delay Relay high precision

TURNER INDUSTRIES, INC., 2 Harding Ave., Endicott, N. Y., announces a new low cost adjustable reset timer. It gives repeat accuracy of 0.1 percent over the total range, and split-second reset time. The timer is available in several different models that provide timing intervals for adjustable ranges from nominal 0 to 8.2 hours. Models are available for 25, 50 and 60 cycles, 110 v a-c. **Circle 345 on Reader Service Card.**



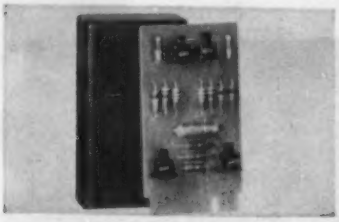
D-C Power Supplies heavy duty

UNIVERSAL ELECTRONICS CO., 1720 Twenty-Second St., Santa Monica, Calif., announces a line of unregulated heavy duty d-c power supplies designated as the V series. Model V40-15 has a continuously variable output voltage of 0-40 v, at currents of 0-15 amperes. A-C input is 115 v, 1 phase, 60 cycles. The V series feature semiconductor rectifiers, and have been developed for rugged service in transistor development, production testing, instrument calibration, relay operation and for general lab utility. **Circle 346 on Reader Service Card.**

R-F Filter low loss

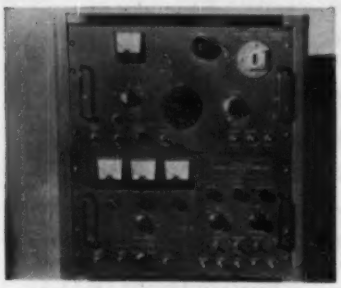
MICROPHASE CORP., Box 1166, Greenwich, Conn., has developed a band-pass/band-suppression filter for simultaneous ATC transmissions on adjacent channels in the lower kmc range from a single antenna. Channels are separated

better than 30 db, and loss in the pass frequencies is less than 1 db. **Circle 347 on Reader Service Card.**



Operational Amplifier
transistorized

BURR-BROWN RESEARCH CORP., Box 6444, Tucson, Arizona. By selection of his own feedback network, the user can obtain a wide variety of overall performance with the new model 130 series amplifier. These units are high gain d-c differential amplifiers having two inputs and two outputs. Designed as plug-in units measuring 1 by 2 by 3¼ in., they are useful in both a-c and d-c applications. Open loop gains from 60 to 85 db are available with phase correction to insure stable operation at all gain level. **Circle 348 on Reader Service Card.**



Radar Tester
target generator

REMANCO, INC., 1630 Euclid, Santa Monica, Calif. The RTS-100 is a complete radar test set, capable of simulating targets under completely dynamic conditions. Simplified preflight testing under tactical conditions is possible. The RTS-100 consists of two packages—the MTG-100X microwave target generator and the RP175 moving video target simulator. Continuous adjustable

"... JUH HEAR THE ONE ABOUT THE SIGMA RELAY FOR A BUCK?"
"LAND SAKES -A CHEAP SIGMA RELAY!"
"HONEST CHARLIE - I'M TELLIN YA SIGMA MAKES PLAIN LITTLE RELAYS"
"I SAY, WITHERSPOON, HERE'S AN ODD SPOT: A SIGMA RELAY FOR SIX BOB"
"HEY AMBROSE - LETS FLY OVER AND SEE THE NON-MILITARY SIGMA RELAY"
"ANY TRUTH TO THAT RUMOR ABOUT A SIGMA RELAY FOR US POOR FISH?"

Our only regret about these conversations is the element of amazement, disbelief or surprise present in all of them. Apparently, we've been so busy all these years convincing people we could build complicated, high priced, MIL spec relays in small quantities that nobody* even gives us a competitive come-hither when they want a good, plain, cheap relay deliverable by the carload. Well, there are Sigma relays for short-haired jobs, and the 11F is an example. The "eleven" has been completely tooled for more than two years now, so it's no worry to the Eng. Dept. Delivery schedules in excess of 5000 per week are being met. The Sales boys like it because it sells for under a dollar (big quantities, of course). For on-off SPDT switching of 1 or 5 ampere loads on 50 mw. or 200 mw. DC, 0.3 volt-ampere AC, with a mechanical life of 100 million operations, it's hard to find anything as compact, cheap and dependable as the 11F. For things like tape recorders, remote control units for toys and TV sets, headlight dimmers, or other gadgets requiring UL approval, the "eleven" is a natural. Sample quantity prices are $1.50 to $2.45 each, list. Bulletin on request.

*well, hardly anybody.

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target velocities up to 5,000 fps, accelerations up to 30 g's and ranges up to 30 mi are available in the standard unit. **Circle 349 on Reader Service Card.**

Gage Guard in four ranges

INDUSTRIAL ENGINEERING CORP., 525 E. Woodbine, Louisville, Ky., announces a new device offering positive protection for such instruments as incline manometers, draft gages, electrical pressure switches, and ultra-sensitive low-pressure transducers. The Gage Gard Jr. is repeatable and will reopen after sealing at 2 percent below the cut-off point. Adjustment and resetting of cut-off pressure point can be made at any time. The new device is available in four ranges, covering the span of -15 psig to $+85$ psig. **Circle 350 on Reader Service Card.**

Thermistors useful to 1,200 F

FENWAL ELECTRONICS, INC., Mellen St., Framingham, Mass. Use of thermistors has been extended to new applications by the development of beads to function continuously at 1,200 F. Previous temperature limit of thermistors was 600 F. These beads, presently available in bare form with attached leads and without glass coating, have a resistance of 250,000 ohms at 25 C, 0.7 dissipation constant, and 2 second time constant. They are completely stable within their temperature limits and can be used up to 1,800 F with moderate stability. **Circle 351 on Reader Service Card.**

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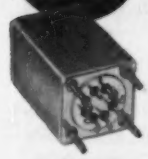

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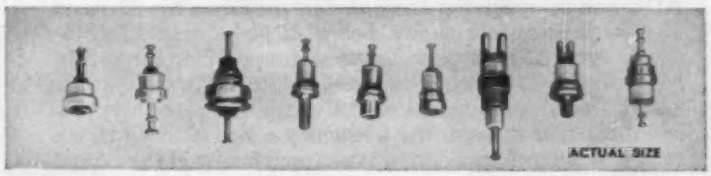

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- **50 CPS to 10,000 CPS frequency response**
- **0.5 second time response**
- **Low output impedance**
- **High input impedance**

Now, for the first time, laboratory standard accuracy readings of AC voltages (from 20 millivolts to 300 volts) are achieved without sluggishness, excessive loading, and nonlinear scales. Model 1240 provides a precision DC output directly proportional to the TRUE RMS of an applied AC voltage regardless of the waveform of the input. Linear DC output has low impedance for meter, analog recorder, data processing system. Combined with DC digital voltmeter operates as precision AC digital voltmeter.

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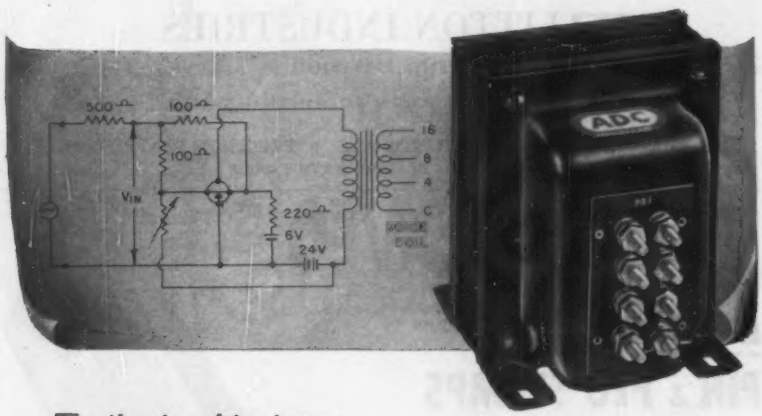
CIRCLE 235 READERS SERVICE CARD

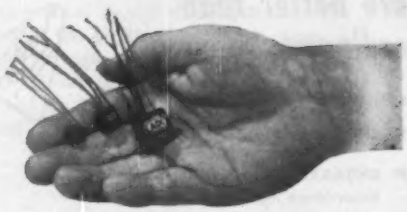
Capable Transistor Transformer design is simple as

Capable transistor transformer design is simple at ADC. The problems are no different than those for vacuum tube circuits. And ADC has been solving these design problems for 22 years.

The transformer shown below at right, was ADC designed as an experimental output transformer for use by Minneapolis Honeywell with their H200E Power Tetrode. This transformer is capable of delivering up to 20 watts with low distortion through the frequency range of 20 to 20,000 cycles. A typical application is pictured below in the class A amplifier circuit.



The tiny transistor transformers such as those illustrated at the right are for low power applications. Introduction of new, low distortion, power transistors has required larger transformers, especially for operation at low frequency. While these may be new to transistor circuits, the design problems and solutions are identical with those of vacuum tube circuitry.



Whether you are interested in transformers for use with transistors or vacuum tubes, it will be to your advantage to come to a firm with the design experience of a pioneer like ADC.

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Literature of

MATERIALS

Oxide Remover. MacDermid Inc., Waterbury, Conn. Technical data sheet No. 77 describes Metex L-5, an acid base liquid which may be used to clean copper-clad phenolic base printed circuit boards or silver-plated circuits after chromic acid strip. **Circle 370 on Reader Service Card.**

Plastic Laminate. Duralith Corp., 1025 Race St., Philadelphia 7, Pa. Backlighted dials and panels are described in bulletin 58-A. Other applications for the process of laminating clear plastic over printed markings for protection are also described, including applicable military specifications. **Circle 371 on Reader Service Card.**

COMPONENTS

Contact Selection. Stackpole Carbon Co., St. Marys, Pa. Catalog 12-A is a 54-page manual of contact selection and use containing a wealth of data on composition contacts produced from powders. Copies are available to contact users on letterhead request.

Toroids, Filters. Burnell & Co., 10 Pelham Parkway, Pelham, N. Y. The importance of toroids, filters and related networks in military, industrial and commercial applications is emphasized in catalog No. 104. **Circle 372 on Reader Service Card.**

R-F Induction Heating. Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y., has available a booklet describing the characteristics and functions of a wide variety of power tubes in r-f induction heaters. **Circle 373 on Reader Service Card.**

Frame Grid Tubes. Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y. A recent brochure contains a description of what the frame grid is, how it is made, specific applications, and a

the Week

comprehensive working definition of tube life and reliability. **Circle 374 on Reader Service Card.**

Delay Lines. Digitronics Corp., Albertson Ave., Albertson, L. I., N. Y. Catalog DL-78 describes results of improved design in construction of Dykor lumped constant and continuously variable delay lines. **Circle 375 on Reader Service Card.**

Cost Cutting Aids. Alden Systems Co., Alden Research Center, Westboro, Mass., has published a handbook on its Work Center System. It deals with a wide line of standard off-the-shelf, unit, building block components. **Circle 376 on Reader Service Card.**

Electronic Encapsulation Cups. Electronic Production & Development, Inc., 138 Nevada St., El Segundo, Calif. A single-page bulletin illustrates and lists physical and electrical properties, as well as the many prime advantages of a line of encapsulation cups for electronic components. **Circle 377 on Reader Service Card.**

Subminiature Selenium Diodes. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif. Bulletin SR-163 covers a line of subminiature selenium diodes developed specifically for applications where ambient temperature is high and savings in space and weight are prime considerations. **Circle 378 on Reader Service Card.**

EQUIPMENT

True RMS VTVM. Trio Laboratories, Inc., Seaford, N. Y. Bulletin 58-114 contains an illustrated description, specifications and price of the model 120-1 0.25 percent true rms vtvm. **Circle 379 on Reader Service Card.**

Go-No-Go Gage. Computer-Measurements Corp., 5528 Vineland Ave., N. Hollywood, Calif. A four-page bulletin describes a new electronic go-no-go gage designed

Smallest MOLDED* MICA CAPACITOR
73% Smaller†
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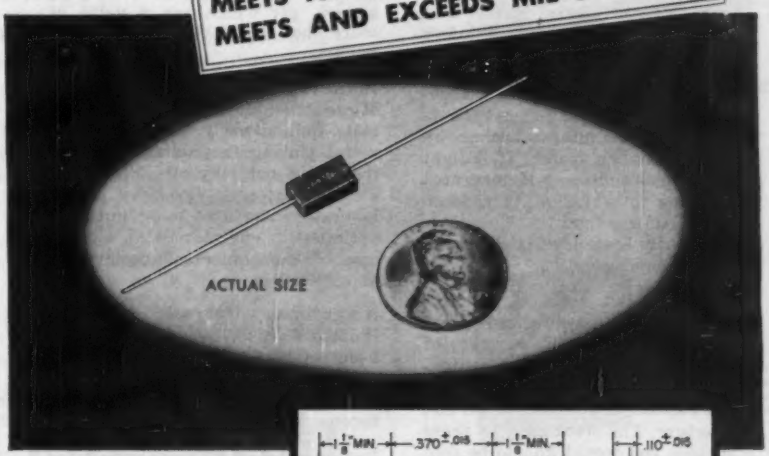

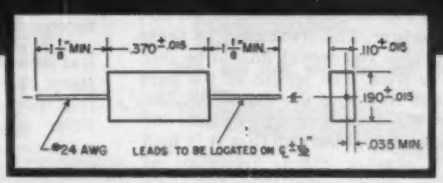

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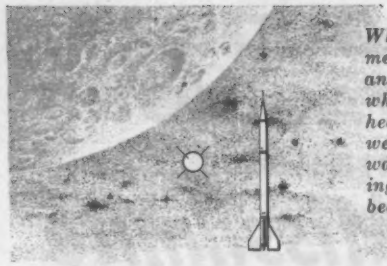

When Marconi winged out the original message on his clumsy wireless, weight and space were not disturbing factors . . . when the Wright brothers flew their first heavier than air machine at Kitty Hawk, weight and precision were vital but space was not critical. Now that we are "reaching for the stars" these elements have become a designer's nightmare!

Reaching For The Stars

THE ROMANCE OF MICRODOT

A few short years ago when Microdot's development engineers started their work in the electronic field the smallest coaxial cable was approximately the size of a man's thumb. It was heavy and inflexible.

Today Microdot produces "Mininoise" Coaxial Cable, which is smaller in circumference than an ordinary kitchen match. It is light and flexible, and the self-generated noise, due to vibration, is reduced to a level of less than 1%. This cable has recently been developed for use in 500°F. environment.

When you walk into the machine shop area of the Microdot factory, you might first observe a battery of automatic Swiss Screw Machines making micro-miniature components for miniature receptacles and connectors. The stock used by these machines you would find to be coin silver wire. The length of the part is .240 inch and the diameter, .030. The machine has generated and produced this part so that it is held to a plus or minus tolerance of .00025. You would hold this tiny part in the palm of your hand and then learn that it has to be put on a precision lathe, individually, to produce thereon a slot .006 wide.

In aircraft, missiles, satellites, ground to air, and air to air communication and control systems: weight, space and precision are ever present problems of the design engineer. The increased demand for control, and the more refined control required results in greater need for more electronic equipment.

The cry then is for micro-miniature and yet highly reliable electronic equipment. Light weight is not enough. Electronic equipment must be small, as small as possible. What is called for is micro-miniaturization.

Microdot has pioneered this field and now produces coaxial connectors and cables which are ⅛ the size, ⅓₀ the weight of what was formerly acceptable. Individually made by adroit mechanics on exacting machines, to the highest precision known.

Upon visiting Microdot you would also see millions of precision components stored in an area 10x10 feet square, yet which has a value of more than a quarter of a million dollars.

In the fabrication of its components, Microdot employs only prime materials. Coin silver, precision precious metal plating for contacts, Teflon, irradiated polyethylene . . . and dielectric materials developed in our laboratory are used to produce the optimum in environmental, electrical and mechanical characteristics of connectors.

An ordinary coffee cup holds seven thousand parts, each of which has been machined to precision and individually handled in the secondary operation. These components become Microdot connectors.

But of course, this is not the total story. To achieve perfect production requires accurate inspection. First of the stock, then of the machined component. Next, further minute examination after the secondary operation, and lastly a thorough scrutinization of the connector and receptacle, which includes environment, vibration, as well as electronic performance ability tests.

In all human endeavor the attainment of perfection comes high, so it is true that Microdot's near perfect product is costly, but with it go precision performance and utter dependability.

Research at Microdot is a continuing process . . . working on "specials" a day-to-day job. Microdot is daily solving problems that involve the conservation of weight and space, and for perfect performance, Microdot's technical staff is ready and eager to assist you.

Microdot sales engineers are located in most principal cities, or you can contact Microdot, Inc., at 220 Pasadena Avenue, South Pasadena, California. Phone RYan 1-3351, SYcamore 9-9128. Our Eastern Division is located at: Microdot, Inc., Room 214 Wilford Building, 101 North 33rd Street, Philadelphia 4, Pa. Phone Baring 2-2350.

for frequency stability and comparison checks, motor speed control, pressure and flow control, material flow control, and other limiting situations occurring between 1 and 40,000 times per sec. **Circle 380 on Reader Service Card.**

Test Equipment. Kingston Electronic Corp., Medfield, Mass. A new 12-page, two-color catalog of test equipment provides detailed descriptions of three models of absorption analyzers and accessory equipment. Also included are other test instruments produced by the company. **Circle 381 on Reader Service Card.**

Electronic Computing Machine. Clary Corp., San Gabriel, Calif., offers a 16-page brochure on its electronic computing machine. It describes the specific areas where the $15,000 unit can save an engineering department time and money in its calculation and computer work. **Circle 382 on Reader Service Card.**

Primary Standard Radio Receiver. J. L. A. McLaughlin Corp., La Jolla, Calif. An illustrated description and applications of Model One tunable primary standard radio receiver are contained in an 8-page booklet. Unit discussed is stable to within one part in a billion per day. **Circle 383 on Reader Service Card.**

Digital Computer Control. The Thompson - Ramo - Wooldridge Products Co., 5500 W. El Segundo Blvd., Los Angeles 45, Calif. A new reference bulletin includes a description of the RW-300 digital control computer as well as comprehensive discussions of process control, data logging, pilot plant, and test facility applications for computer control systems. **Circle 384 on Reader Service Card.**

Modular Instrument Enclosure. Amco Engineering Co., 7333 W. Ainslie St., Chicago 31, Ill. The fundamentals of the Amco modular instrument enclosure system are covered in detail in a 64-page catalog. Booklet is organized to help the busy engineer quickly locate the information needed to specify the

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Modine transistor coolers

Available for the first time in standardized module and strip forms! New Modine aluminum transistor coolers effectively dissipate heat generated by compact electronic circuits. Maximum-heat-transfer design holds transistor junction temperature safely within design limits. Systems equipped with refrigeration cooling, ram air or blowers provide suitable air supplies for these coolers. Size requirements can be quickly determined by consulting our Bulletin ID-158, which contains performance data and application information.

For full details on standard and custom-built Modine transistor coolers, plus Bulletin ID-158, write Electronic Cooling Dept., Modine Manufacturing Company, 1602 DeKoven Avenue, Racine, Wisconsin.

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- Impedances: 200 to 10,000 Ω
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- Linear phase shift

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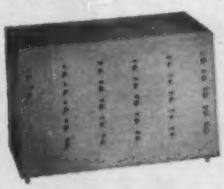
BANDWIDTHS to 500 MCS,
Zo FROM 50 TO 10,000 OHMS.



Multi-tapped Lumped Constants available in many configurations.

System Delay Lines

Complete delay and pulse systems designed to your needs.

NOTE: Data Sheets on request

CEC CONTROL ELECTRONICS CO., INC.
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the head of the family

The Couch Type 4A relay heads a family of rugged relays — relays that can withstand the extremes of shock, vibration, and acceleration — all because of a unique patented rotary armature design. The 4A design will answer your dry circuit switching problems too. Our Bulletin 132 will tell you more. Write for it today.

IMPORTANT SPECIFICATIONS

Contacts: 4PDT (4 Form C)

Size & weight:
1 3/32" D x 1 1/2" H, 3.2 oz.

Pull-in power: ½ watt

Ambient temperature:
-65°C to 125°C

Vibration resistance:
20G, 5 to 2000 cps

Shock resistance:
75G operating
200G non-operating

Illustrated on the right are some of the many possible mounting variations available.

Couch ORDNANCE INC.

A Subsidiary of S. H. Couch Co., Inc.

3 Arlington Street
North Quincy, Mass.

exact assembly to best meet specific requirements. **Circle 385 on Reader Service Card.**

Pulse Instruments. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif. A 4-page 2-color brochure covers specifications and prices for a line of pulse generators, block units for special purpose pulse instrumentation, magnetic core testing equipment, and electronic counters. **Circle 386 on Reader Service Card.**

Test Equipment. The Presray Corp., subsidiary of Pawling Rubber Corp., Pawling, N. Y. Engineering bulletin No. P.R.206 contains a listing of key personnel, an organization chart, and a partial list of customers for the company's design, development and production of specialized test equipment. **Circle 387 on Reader Service Card.**

Tachometer System Tester. Consolidated Airborne, Systems, Inc., 72 E. 2nd St., Mineola, N. Y. An 8-page brochure provides technical data, functional schematics, and performance specifications on the model TT-3 tachometer system tester, which has been designed to meet the requirements of MIL-T-26219 (USAF). **Circle 388 on Reader Service Card.**

Instrumentation Tape Recorders. Mincom Division, Minnesota Mining & Mfg. Co., 2049 S. Barrington Ave., Los Angeles 25, Calif. A technical brochure describes the characteristics, specifications and operating features of the new model C-100 series of instrumentation tape recorders. **Circle 389 on Reader Service Card.**

FACILITIES

Facilities Brochure. Sargent Engineering Corp., 2533 E. 56th St., Huntington Park, Calif., has published a 52-page brochure detailing the history, organization and complete facilities available for research, design, qualification and manufacture of hydraulic, pneumatic, electronic and mechanical components. **Circle 390 on Reader Service Card.**

INCREASED INSULATION
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Terminal Strips

Leakage path is increased—direct shorts from frayed terminal wires prevented by bakelite barriers placed between terminals. Binder head screws and terminals brass, nickel plated. Insulation, molded bakelite.

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No. 2-142-Y

Shown: Screw Terminals—Screw and Solder Terminals—Screw Terminal above, Panel with Solder Terminal below. For every need.

Six series meet every requirement: No. 140, 5-40 screws; No. 141, 6-32 screws; No. 142, 3-32 screws; No. 150, 10-32 screws; No. 151, 12-32 screws; No. 152, ¼-28 screws.

Catalog No. 22 lists complete line.

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HOWARD B. JONES DIVISION
CINCH MANUFACTURING CORPORATION
CHICAGO 24, ILLINOIS
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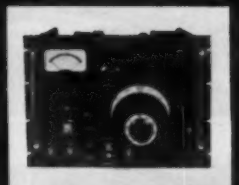

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Industry's preferred "instrument of a thousand uses". Accurate, rugged, versatile STANDARD Elapsed Time Indicators. Synchronous motor drive. Electric clutch controlled by manual or automatic switch or output of electronic tubes. Manual or electric zero reset. Units for flush panel mounting or portable use.

PANEL MOUNTED

PORTABLE

Model	Scale Divisions	Totalizes	Accuracy
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min.
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.

Request Bulletin No. 198.

THE STANDARD ELECTRIC TIME COMPANY
89 LOGAN STREET • SPRINGFIELD, MASSACHUSETTS

CIRCLE 246 READERS SERVICE CARD

Firm Opens Eighth Plant

ACOUSTICA ASSOCIATES, INC., manufacturer of ultrasonic equipment used in both missiles and industry, recently opened its eighth and largest new plant, at Inglewood, Calif.

The 15,000-sq ft plant will produce airborne missile fuel control systems containing ultrasonic liquid level sensors for the Atlas missile under the company's prime Air Force contract exceeding $1 million.

Acoustica, whose main headquarters and plants are in Mineola, L. I., N. Y., has two other California plants in Culver City, opened since last February.

"The company has just completed the most successful six-month period in its three-year history," reports Robert L. Rod, president. "Sales for the first six months total more than twice the sales for all of last year. We expect this increase rate to continue."

Acoustica, in addition to its prime contract with the Air Force Atlas program, was awarded Army contracts this summer for ultrasonic liquid level sensors used in loading fuels into various missiles at the Army Redstone Arsenal, Huntsville, Ala. The firm's liquid level sensor is also used in the Navy's Polaris missile produced by Lockheed Aviation.

Watkins-Johnson Hires Four

FOUR ADDITIONS to the technical staff of Watkins-Johnson Co., Palo Alto, Calif., are announced.

Recently joining the firm, which specializes in microwave tubes and electron devices, were George Wada, O. Thomas Purl, Bruce G. Bleecker and William V. Christensen.

Wada was a research assistant at the Stanford Electronics Laboratories from 1955 until joining Watkins-Johnson.

Purl was formerly section head of the power traveling-wave tube section of the Research Laboratories of Hughes Aircraft Co., Culver City, Calif.

Bleecker came to his new position from Litton Industries, San Carlos, Calif., where he was in charge of the JC-W magnetron assembly department.

Christensen was previously with Huggins Laboratories, Palo Alto, where he was responsible for production engineering of traveling-wave tubes.

Advance Key Men At Tamar, Inc.

CREATION of a new executive post, and two top engineering promotions at Tamar Electronics, Inc., Los Angeles, Calif., are announced.

John S. Overholser, Tamar's chief engineer was named director of research engineering; Kenneth E. Wilcox, assistant chief engineer, was appointed chief engineer; and Rex C. Bean, chief microwave engineer, was promoted to assistant chief engineer.

Avion Names Lab Managers

PROMOTIONS of Harold P. Belcher to manager of the Quick Reaction laboratory and Lawrence R. Hendershot to manager of the Special Projects laboratory, have been announced by M. L. Bond, manager of the Alexandria, Va., plant of Avion Division, ACF Industries, Inc. Both formerly held the position of senior engineer.

Servomechanisms Appoints Reid

NEW chief engineer of Servomechanisms' Subsystems Division, Hawthorne, Calif., is J. H. Reid.

He was in charge of electronic systems predesign at the Convair Division of General Dynamics Corp., and prior to his association with Convair, was a project engineer with the A. B. DuMont Laboratories.

Microlab Adds Section Head

HERBERT F. ENGELMANN recently joined the engineering staff of

NOTABLE ACHIEVEMENTS AT JPL...

PIONEERS IN MOBILE MISSILE SYSTEMS

The "Sergeant's" excellent mobility characteristics, including the ability to operate under conditions of winter snow, ice, mud, desert sand and heat, significantly extend the capabilities of the system for close support of a ground command in our modern United States Army. The ease of operation and handling permits the weapon to be unloaded from airplanes or landing craft and be ready for firing with a minimum of preparation.

The system concept demonstrated in the "Sergeant" has permitted excellent mobility and speed of operation to be attained. The requirements of the Army have been stressed, resulting in outstanding characteristics of the weapon meriting the title of "America's first truly 'second generation' surface-to-surface tactical missile."

The responsibility for accomplishing this important achievement has been placed on JPL by the United States Army Ordnance Missile Command.

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HIGH POWER—0-400 v d-c, 250 ma cont, 500 ma int, continuously adjustable
COMPACT—only 5 in. wide, 6½ in. deep, 10 in. high; wt—20 lbs
DEPENDABLE—no tubes . . . no warm up . . . no maintenance
VERSATILE—production testing, lab supply, industrial test supply
ECONOMICAL—net price FOB Pittsburgh, Pa. . . . $99.50

GET ALL THE FACTS . . . write to Westinghouse Electric Corp., Director Systems Dept., 356 Collins Ave., Pittsburgh 6, Pa. Complete information about new Volt-Pak will be sent to you promptly. J-22142

Electronic Wholesaler Inquiries Invited

YOU CAN BE SURE...IF IT'S Westinghouse

Microlab, Livingston, N. J., as head of the development section.

Past national chairman of the IRE Professional Group on Microwave Theory and Techniques, Engelmann has had several papers published and has been granted numerous patents in the microwave field.

Formerly with Federal Telecommunications Labs, as executive engineer and department head since 1944, he also had several years experience with U. S. Naval Research Laboratories, Washington, D. C.

Appoint Backus Mycalex Director

ALFRED S. BACKUS was recently appointed director of Mycalex Electronics Corp. and Mycalex Tube Socket Corp., affiliated companies of Mycalex Corp. of America, Clifton, N. J.

Backus has spent 20 years working with glass-bonded mica, first as foreman in charge of production at General Electric. He joined Mycalex in 1944.

Name Ochlis To New Epsco Post

BOSTON'S Epsco recently appointed Samuel Ochlis sales manager of the

Instrument and Equipment Division. Function of this division is to design and manufacture building blocks in large data handling systems which are used in the automatic check-out and data monitoring in the missile and industrial data processing field.

Prior to this appointment, Ochlis was sales manager at Arthur C. Ruge Associates.

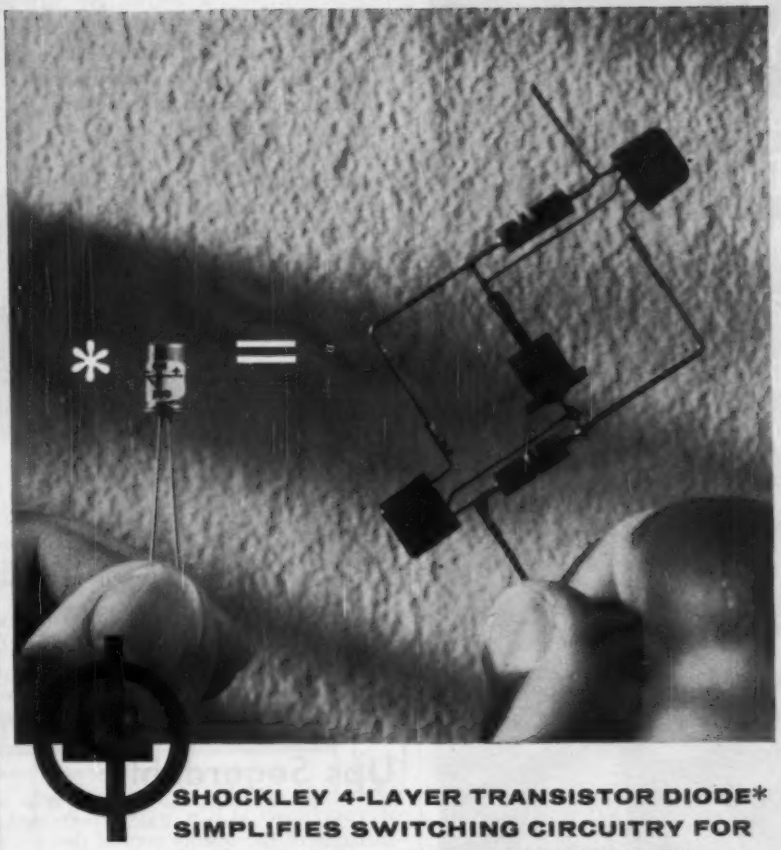
Ultradyne Names V-P and G-M

ARTHUR W. MILLER has been appointed vice president and general manager of Ultradyne, Inc., manufacturers of pressure transducers and electromechanical products in Albuquerque, N. M.

He has had over thirty years' manufacturing and management experience while with Bucyrus Erie of Milwaukee, Wisc., and Sandia Corp., Albuquerque.

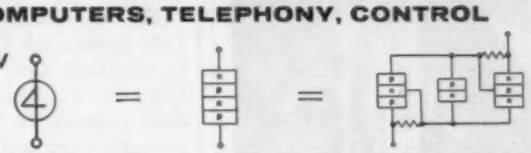
Tarr Shifts At Cinch Mfg.

ANNOUNCEMENT is made of the retirement of Lester W. Tarr from



SHOCKLEY 4-LAYER TRANSISTOR DIODE* SIMPLIFIES SWITCHING CIRCUITRY FOR COMPUTERS, TELEPHONY, CONTROL

HERE'S HOW



2-terminal switching diode ... with 4 layers, alternate n and p type ... can replace conjugate structure of 5 components

RANGE OF CHARACTERISTICS

V_b (breakdown voltage)	20-100v
I_b (breakdown current)	< 500 μa
V_h (holding voltage)	< 2V
I_h (holding current)	< 50 ma
R_b ("on" resistance)	< 20 ohms (from 1—3 amps., voltage < 1 volt plus 0.2 to 1.5 ohms times current)
Dissipation	≈ 100 mw
Time to close	< 0.1 μsec
Time to open	< 0.2 μsec

STANDARD TYPES AVAILABLE FOR DELIVERY NOW

No.	V_b Volts	I_b μa	V_h Volts	I_h ma	R_b ohms
4N20D	20±5	< 500	< 2	< 50	< 10
4N30D	30±5	< 500	< 2	< 50	< 10
4N40D	40±5	< 500	< 2	< 50	< 10
4N50D	50±5	< 500	< 2	< 50	< 10

ENGINEERING DATA AND ASSISTANCE

Our engineering staff, under the direction of Dr. William Shockley, will undertake circuit problems in typical applications such as: sawtooth oscillators, pulse generators, bistable circuits, ring counters and various switching functions. Special types of transistor diodes are being developed to individual specifications. Technical information on request. Write to Dept. 1A-9KS.

*Invented at Bell Telephone Laboratories.

Shockley Transistor Corporation

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Los Angeles 24, Cal.

CIRCLE 250 READERS SERVICE CARD

the presidency of Cinch Mfg. Corp., Chicago, Ill., manufacturers of electronic components. He will remain on the board of directors of Cinch and will serve as a consultant to United Carr Fastener Corp., parent corporation of Cinch. Tarr had been president of Cinch since 1944.

E. J. Pool, who has been executive vice president of Cinch, has been appointed acting president.

Ford Instrument Ups Segerdahl

APPOINTMENT of Roy Segerdahl as manager of the quality control division, was recently announced by Ford Instrument Co., division of Sperry Rand Corp., Long Island City, N. Y. Previously assistant chief engineer, he was responsible for engineering and manufacturing services as well as the activities of the ground equipment section of engineering.

In his new position Segerdahl will manage the company's quality control, test, inspection and field service activities.

News of Reps

Ace Electronics Associates, Inc., of Somerville, Mass., has named **A. C. Wahl Co., Inc.** of Cincinnati, Ohio, as rep for its entire line of precision potentiometers and related components, in the Kentucky and southwestern Ohio areas.

Transformers and audio amplifiers of Langevin Division, The W. L. Maxson Corp., will be sold in New York City and Nassau, Suffolk and Westchester Counties in New York and northern New Jersey by **Robert J. Marcy Associates**; in southern

Anywhere...
At sea, in the icy cold of the antarctic! S.S.WHITE Molded Resistors in values up to 50,000 megohms retain their characteristics.
in Any Weather
Airborne, in the steaming heat of the tropics! S.S.WHITE Molded Resistors are made of coated, non-hygroscopic material that resists moisture.

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"ALL-WEATHER"

Molded Resistors Withstand Temperature and Humidity

FIXED RESISTANCE VALUES RANGE FROM 1000 OHMS TO 10,000,000 MEGOHMS!

65X Molded Resistor — 1 watt
80X Molded Resistor — 3 watts

While bargain buys in resistors are wearing out and being replaced, durable S.S. WHITE "All-Weather" Molded Resistors are still giving top performance in hundreds of commercial, industrial and scientific applications.

Our resistors are characterized by low noise level . . . precision . . . stability . . . have negative temperature and voltage coefficients. Compact . . . excellent stability and mechanical strength . . . values do not deteriorate due to age.

We'll be glad to cooperate with you in applying these high-quality resistors to your product. For our Bulletin 5409, just drop a line to Dept. R.

S. Silbhite

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lower costs . . .
improve design
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GRC die cast GEARS & PINIONS

Cast in one piece, at one time — and one low unit cost! Produced precisely to your specifications, permitting a wide flexibility of *design heretofore impractical.* One-piece assemblies can be cast with shafts or center holes, or in combination with cams, hubs, spacers, flanges and other mechanical elements. Maximum size: 1-5/16" outside diameter x 1/16" face width; wider faces for smaller diameters.

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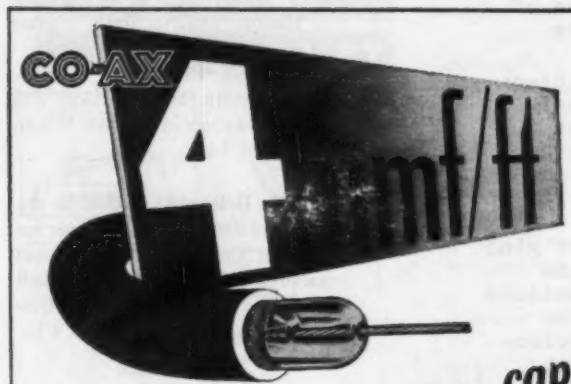

★ ULTRA LOW capacitance & attenuation

TYPE	μμ F/ft	IMPED.Ω	O.D.
C 1	7.3	150	.36"
C 11	6.3	173	.36"
C 2	6.3	171	.44"
C 22	5.5	184	.44"
C 3	5.4	197	.64"
C 33	4.8	220	.64"
C 4	4.6	229	1.03"
C 44	4.1	252	1.03"

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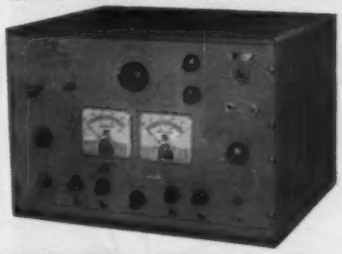
NOW Baird-Atomic transistor test sets WITH EXTENDED RANGES!



KP-2 series

with Semiconductor Regulated Power Supplies for Ease of Operation.

New Ranges Available

Model	Current Range	Collector Voltage Range
KP-2	up to 1 amp	100 volts
KP-2SB	up to 1 amp	200 volts
KP-2SC	up to 2 amp	100 volts
KP-2SD	up to 2 amp	200 volts

Maximum Power 75 Watts

Plus these added features:

- Common Base or Common Emitter
- Frequency Range — 100 cps to 200 kc
- Direct measurement of h parameters plus α and β cutoff
- Meter indication of DC parameters, I_{co}, I_{eo}, BV_{cer}, V_{ebf}

All models available with built in VTVM and oscillator at extra cost.

The KP-2 Transistor Test Sets are versatile, precision instruments added to B-A's other transistor testing equipment: *Model GP-4* for h parameters — 100 cps to 1 mc; *KT-1 Portable* for measuring Beta, h_{ie} and I_{co}.

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Instrumentation for Better Analysis

Baird Atomic

Baird-Atomic, Inc.

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Experienced Pulse Circuit and Communications Engineers — write to Technical Personnel Director.

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A RADICAL APPROACH

Cooling heat-producing components of a high-temperature, high-voltage transformer with a boiling liquid hermetically sealed in its case may seem a bit radical to the uninitiated. But if the liquid is a high-dielectric fluorochemical, like that used in air conditioning systems, the idea begins to make sense.

As the vapor comes in contact with the fan-cooled surface of the transformer case it condenses to a liquid, and gets rid of its heat to the surrounding atmosphere.

In a recent project completed by Raytheon engineers, six ounces of fluorochemical vapor and a one-pound fan did a better cooling job than 20 pounds of transformer oil. Operating temperatures were reduced as much as 75° C.

Our engineers will be glad to initiate you in the miniaturization techniques made possible by these versatile coolant-dielectrics. Simply contact:

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Magnetic Components Department
Section 6120
Waltham 54, Massachusetts

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Excellence in Electronics

New Jersey, Delaware and Maryland, by **Andrew A. Foley Associates;** in the New England States, by **Zaslow Sales Co.;** in New York State (except New York City, Nassau, Suffolk and Westchester Counties), by **Leonard D. Allen, Inc.**

Helipot Division of Beckman Instruments, Inc., reassigns sales reps in two territories. The **Allen I. Williams Co.** replaces **G. S. Marshall Co.** as exclusive Helipot rep in New Mexico and the following counties of Texas: El Paso, Hudspeth, Culberson, Reeves, Pecos, Terrell, Jeff Davis, Presidio and Brewster. In turn, the **Marshall** organization is assigned the state of Nevada, unrepresented until now.

Donner Scientific Co., Concord, Calif., names the following new reps:

The Tiby Co. of Cleveland will handle the company's line in Michigan and northern Ohio.

Southern Ohio will be handled by **Laurence D. Bruno** of Dayton.

Design & Sales Engineering Co. of St. Louis, Mo., will cover southern Illinois, western Iowa, Kansas and Missouri.

Hawthorne Electronics with offices in Seattle and Portland will represent Donner in Oregon, Washington and Idaho.

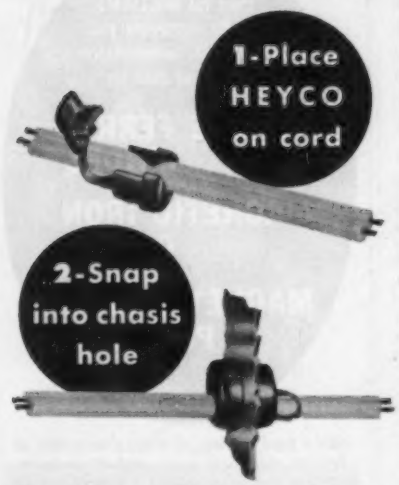
Arthur L. Bolton, formerly sales engineer and district sales manager for Marchant Calculators, has become associated with the **Frank Lebell Co.,** San Francisco rep firm. Bolton will head up the company's Industrial Division.

Fred Spellman Co. is named sales engineering rep in the Metropolitan New York City area for Electro Engineering Works, San Leandro, Calif.

Rogers Corp., Rogers, Conn., has named **Space Engineering** of Pasadena, Calif., to handle its high temperature products in California and Arizona.

Toroids, filters and related networks of Burnell & Co. will be handled in Southern California and Arizona by the **Stevens-Capell Co.**

Protect the life line of your electrical products with Nylon HEYCO Strain Relief Bushings



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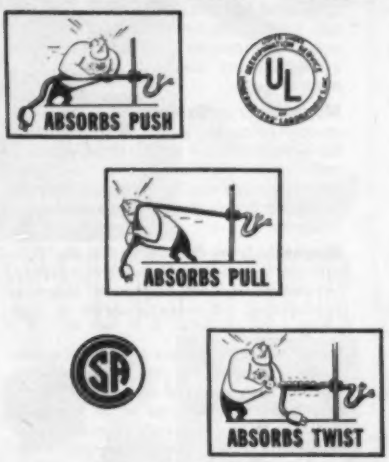

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NEW BOOKS

Switching Circuits and Logical Design

By SAMUEL H. CALDWELL.

John Wiley and Sons, Inc., New York, 1958, 686 p, $14.00.

RECENT years have witnessed the growing importance of digital techniques and in particular data processing systems as branches of electrical engineering study. The design of switching circuits is basic to this field, and the first step in switching circuit design is logical design.

Although the literature has been adequately spotted with significant papers on various aspects of switching circuit theory and practice, the need for an acceptable text for the many switching circuit courses which have been joining the electrical engineering curriculums has not been met prior to the publication of Professor Caldwell's book.

Context—Following two short introductory chapters, the switching algebra is presented in chapter three. In addition to developing the algebra on a self-supporting mathematical basis, the theorems are given physical significance by interpreting them in terms of relay contact networks.

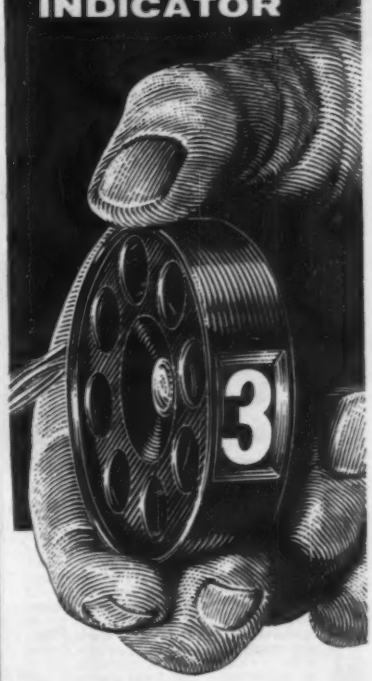
Chapters four through eight treat various topics under the general heading of combinational switching circuits. Included here is a thorough coverage of the latest graphical and algebraic minimization methods.

Having made use of relay contact networks to establish a firm physical basis for the principles and techniques developed in chapters three through eight, the author introduces, in chapter nine, electonic and solid state devices as components of combinational switching circuits.

Switching problems which arise as a result of the use of various coding schemes are handled in chapter ten. Some further uses for the mapping techniques developed earlier in the work are exploited here for use in developing cyclic codes.

The iterative approach to designing symmetric and positional contact networks is the subject matter of chapter eleven. One of the descriptive methods described here

MAGNELINE
NEW DIGITAL READOUT INDICATOR



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MAGNELINE is the ideal indicator for use in computers and electronic systems requiring accurate display. It positions rapidly — produces two-per-second responses with low power.

Simplicity assures long life. Only one integral part is in motion. Featherweight rotor is magnetically activated, rides on precision ball bearing. No mechanical detents or electrical contacts to wear or foul. The 1/8" x 3/16" digits are white on black background to give clear legibility at 25 feet. Even at 60° angle, figures can be quickly and accurately read.

Magneline measures only 21/32" wide by 2 3/64" in diameter. Weighs only 3.3 ounces. Units can be stacked in series for multiple digits. Write for complete technical data.

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A Division of The Patent Button Company

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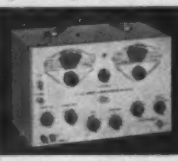

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also serves as an introduction to the principal approach used for describing sequential switching circuits. The addition of the time dimension to combinational switching circuits produces the sequential switching circuit wherein outputs are a function of past as well as present inputs. Such circuits are the subject matter of the remainder of the work.

Sequential Switching—The underlying theory of sequential machines as well as the formal approaches to the synthesis of sequential switching circuits have been developed only in the last four years or so. The approach presented here is the one due in most part to D. A. Huffman of MIT, a colleague of Professor Caldwell. Professor Huffman's work is the one most exploited to date and appears to be quite satisfactory for relay circuits at least. However, some other contributions in this general field, such as the work of E. F. Moore and G. H. Mealy both of Bell Telephone Lab., are regrettably omitted either in substance or reference in the work.

On the other hand, Professor Caldwell has managed to correlate the work on sequential switching circuits done at MIT in a way which will present to the student usable and formal analysis and synthesis procedures. The inclusion of many classroom tested problems at the end of each chapter offers a distinct advantage of the work both as a text and for those computer engineers who would like to examine some of their intuitive design procedures in the light of the newer formal ones.—D. E. ROSENHEIM, *IBM Watson Laboratory at Columbia University, New York, N. Y.*

Transistor Technology

By H. E. BRIDGERS, J. H. SCAFF and J. N. SHIVE.

D. Van Nostrand Pub. Co., Inc., Princeton, 1958, 661 p, $7.50.

IN 1952 two classified books on transistor technology were issued jointly by the Bell Telephone Laboratories and Western Electric Company. These two books have been combined and revised in the present book which is Volume I of a

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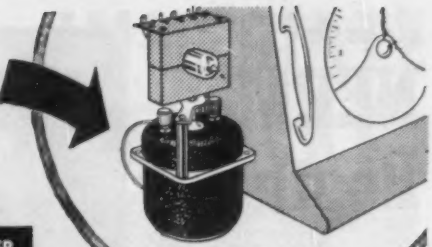

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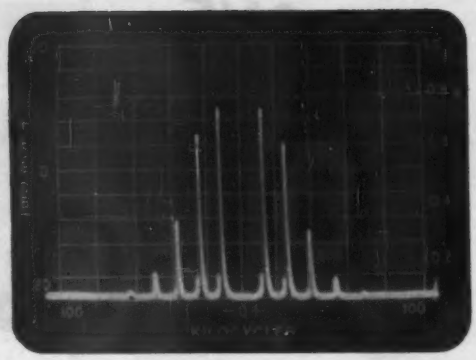
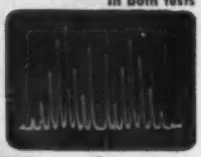


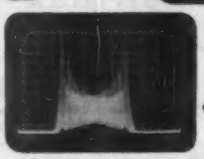
FM Deviation Check 4.3 kc. modulation at first carrier null. Deviation = ± 10.32 kc. Panoramic display shows actual sideband spread including those beyond deviation.

FM problems?

pictures like these give the answers you need for FM operating and equipment testing

Two photos showing FM signals of equal deviations (±55.2 kc) but different energy distributions. FM deviation monitor would read identically in both tests





10 kc modulation at second carrier null

Same modulation level—frequency 1 kc

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- Observe clearly sideband structure under complex forms of modulation
- Analyze carrier shifts, incidental AM, hum, RF harmonics non-linearities . . . detect carrier pulling or instability in both magnitude and direction
- Adjust operating parameters at optimum

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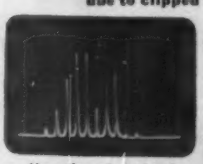
Two photos showing FM due to clipped sine waves.



Relative lack of sidebands to left of carrier (centered on Panalyzor screen) indicate limited deviation on clipped end of oscillator swing

Here the other side is clipped. Note mirror image effect and slight carrier shift.

FM: THEORETICAL AND PRACTICAL ANALYSIS is discussed in a current issue of The PANORAMIC ANALYZER, No. 4. Write, wire, phone for copy and detailed specification bulletins on Panoramic Panalyzors.

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In cases where new ideas have developed, the original text has been brought up to date. For example, avalanche breakdown theory has been substituted for Zener breakdown, some capsulation methods that have been superseded are eliminated and the material devoted to point contact transistors has been reduced.

Context—The book covers a large field ranging from the preparation of pure germanium to the methods of characterizing transistor reliability. The five section headings give a quick summary of the fields covered: Technology of Materials, Preparation of Single Crystals, Principles of Device Fabrication, Principles of Transistor Performance, Characterization and Transistor Reliability. Each section is written by a specialist who has devoted a great deal of time to the subject; 33 people are listed as contributors.

The preparation of high-quality single-crystal germanium is, of course, germane to all devices. The physical principles of this subject are thoroughly covered in the first two sections. Steady state and transient growth conditions are discussed and a chapter on an *npn* crystal growing machine is included.

In discussing device fabrication the material is divided into chapters concerning the fundamental parts or processes composing a transistor. Consequently, the knowledge can be used separately in any combination the reader desires. Sample subjects are: germanium cutting, surface treatment, contacts and capsulation. Most of the discussion on complete device fabrication concerns point-contact and grown-junction transistors. There is perhaps more material devoted to point-contact transistors than many readers require.

For the technology of newer types of high-frequency and power-transistors made by the latest specialized processes the reader will have to wait for volumes two and three.

The principles of measurements are discussed and many circuit diagrams are shown. Values of circuit components are not listed but the factors determining their choice

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are discussed. The listing of precautions that should be observed for a particular parameter measurement should save considerable time for the engineer or student attempting the measurement for the first time.

As pointed out in the Preface, the book attempts to emphasize the application of fundamental principles to device technology. This it has done well. The mastering of all the fundamental principles, (physics, chemistry, metallurgy, electrical measurement etc.) by all device engineers is, of course, a highly desired goal.

All too frequently there is a wide gap in communication between the work of the physicist in the research laboratory and the cookbook approach of the practical engineer in the factory. The amount of published literature that shows the relation between the work in the research laboratory and the solution of a practical problem is usually meager. Assembly of the material in these series of books will fill a void in the literature. Consequently these books should meet an enthusiastic reception by a large group of people. The novice at a university who cannot consult specialists for a particular problem should find the books of particular value.

The excellent index greatly aids in finding specific discussions.

Since two adidtional volumes are in process, comments on completeness are not possible now.—C. W. MUELLER, *RCA Laboratories, Princeton, N. J.*

THUMBNAIL REVIEWS

Industrial Television. By H. A. McGhee, George Newnes, Ltd., Tower House, Southampton St., London, W.C. 2, England, 1957, 120 p, 15s. Practical aspects and principles that govern the choice of camera equipment are covered in the first part of this book along with the design of associated equipment. The second half covers typical applications.

Basic Electrical Engineering. By R. H. Nau, The Ronald Press Co., New York, N. Y., 1958, 437 p, $7.00. This text for electrical engineering students provides background for applied courses in machinery and communications as well as advanced study of a-c circuits.

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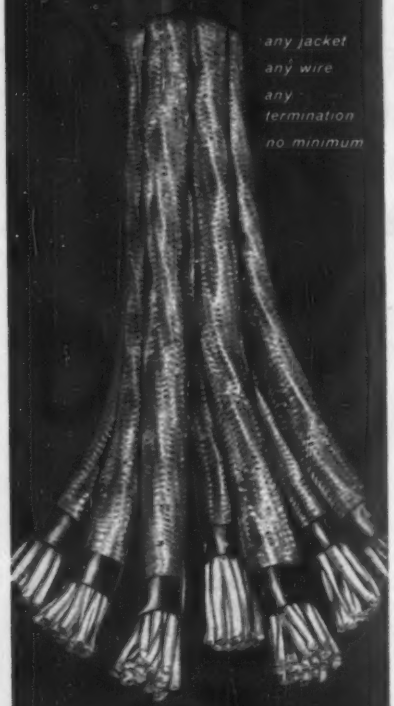

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COMMENT

Radar Nomograph

. . . "Radar Power Nomograph (p 72, July 4) . . . is intended for use in determining the power density in the beam of a radar antenna. Since nomographs usually end up in an engineer's notebook, thereafter to be used indiscriminately, I felt I should call your attention to several errors.

First, the author should have mentioned that his analysis does not apply to the very near field of an antenna. That is, if the antenna diameter is D and the wavelength is λ, the nomograph cannot be used for points closer to the antenna than about $.25D^2/\lambda$. In this region the author's method would yield too high an estimate, becoming increasingly inaccurate as the distance decreases.

Another error which also results in too high an estimate is that the antenna is assumed to have a gain factor of unity, whereas a figure of about 0.6 should be used for a parabolic antenna and perhaps 0.8 for an array. The far-field power density shown in the nomograph should then be reduced by these same factors 0.6 or 0.8, depending on the antenna.

In addition, it is stated that the nomograph can be used for other then pencil beams by using the smallest beamwidth in any plane. This again would give too high an answer. A good approximation would be to use the geometric mean of the two principal plane beamwidths.

Russell M. Brown Jr.
U. S. Naval Research Laboratory
Washington, D. C.

The differences of opinion expressed in this letter and in others already published by us (Comment, p 192, Oct. 10), are all to the good. The problem of measuring radiation from high-power antennas is growing more acute all the time; the more people think about it, the higher the probability that something constructive will emerge.

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(Continued on p. 188)

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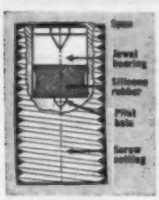

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CIRCLE 275 READERS SERVICE CARD

subject to the attention of our readers as it develops.

Trigger Circuit

Reference "Trigger Circuit Controls Quartz Crystal Lapping" (July 18, p 66):

The development of the trigger circuit control was by Union Thermoelectric under U. S. Army Signal Supply Agency contract DA36-039-sc-71061. The circuit should show that both audio and B+ (also heater current) are derived from the receiver. Frequency, not voltage, is determined by the thickness of the quartz blank. And the abrasive is not liquid, but in a liquid suspension.

ROGER E. BENNETT
UNION THERMOELECTRIC
EVANSTON, ILL.

Stratolab

The current Office of Naval Research *Stratolab* program aims to make available to scientists a manned, sealed, balloon-borne laboratory 20 to 25 miles above the earth for purposes of research, environmental testing and systems experimentation.

If this new research tool which is being offered to scientists is to have maximum usefulness, each prospective user must have the opportunity to participate in determining its specifications.

Accordingly, ONR has asked Vitro Laboratories to put these questions before the scientific community: **Would a manned balloon-borne stratospheric laboratory assist or further your research and development activities? How? What functional requirements—i.e., stability, weight, and so forth—would your activities impose on the Stratolab?**

To provide a forum for discussion, Vitro, ONR and the Institute for Advanced Studies plan to hold a joint symposium dealing with *Stratolab* applications at the end of January 1959. Papers describing possible applications are invited. For further details, please contact the writer.

J. J. FREEMAN
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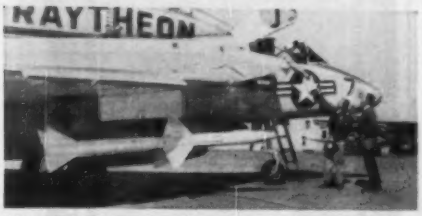
Raytheon Missile Projects



SPARROW III—the Navy's tenacious, lightning-fast, air-to-air missile—is intended for extensive use by Navy fighter aircraft in fleet air defense. Sparrow III is a Raytheon prime contract.

HAWK—the Army's defense against low-altitude attackers—carries out its destruction in the blind zone of conventional radars. Hawk development and production is under Raytheon prime contract.

TARTAR—A substantial contract for vital electronic controls for this Navy destroyer-launched missile is held by Raytheon. This equipment—a tracking radar and associated units—enables it to "lock on", cling to target's path, despite evasive tactics.

ADVANCED PROJECTS in aeronautical structures as well as missile guidance and control are now underway in Raytheon laboratories. New facilities are continually being added for this work.

PRELIMINARY NEW DESIGNS of tomorrow's missiles will result from the advanced work being done by today's missile engineers. Raytheon plays an important role in this area.

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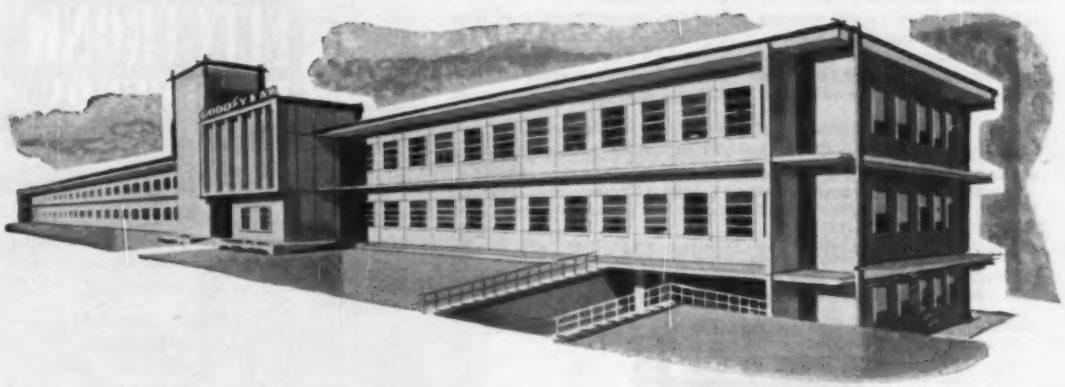

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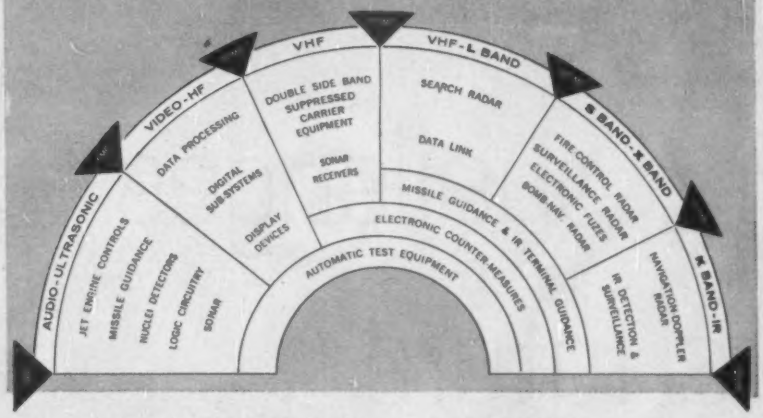

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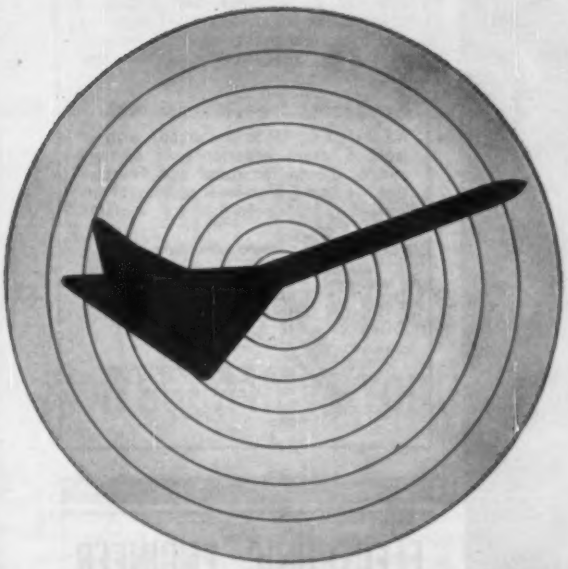
TEST EQUIPMENT ENGINEER John W. Lloyd tells why his work on the B-70 Weapon System at IBM Owego affords him the creative engineering career he always wanted.

WHAT IT'S LIKE TO BE A CREATIVE ENGINEER AT IBM



"Test equipment engineering," says John Lloyd, "is particularly stimulating when it's part of a project as new and important as the B-70, sometimes described as 'a huge flying computer.' Right now I'm coordinating the design of engineering support equipment for an advanced digital airborne computer, part of the B-70's bombing-navigational and missile guidance system. There's a minimum of routine. In order to design test equipment you must know — or learn — about the equipment to be tested; among these are radar, servo systems, digital and analog computers, inertial guidance. I see my professional growth assured as IBM continues to develop computers for airborne applications."

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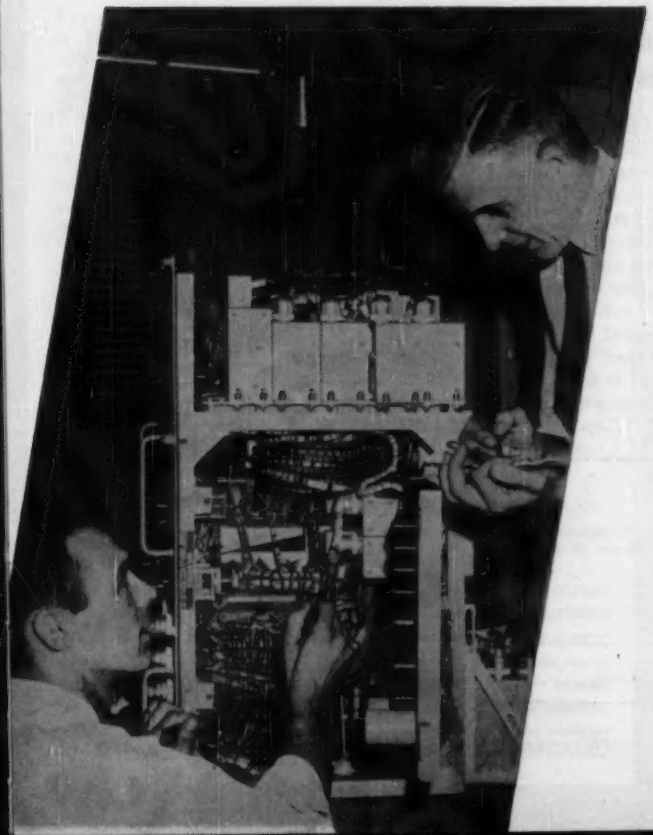

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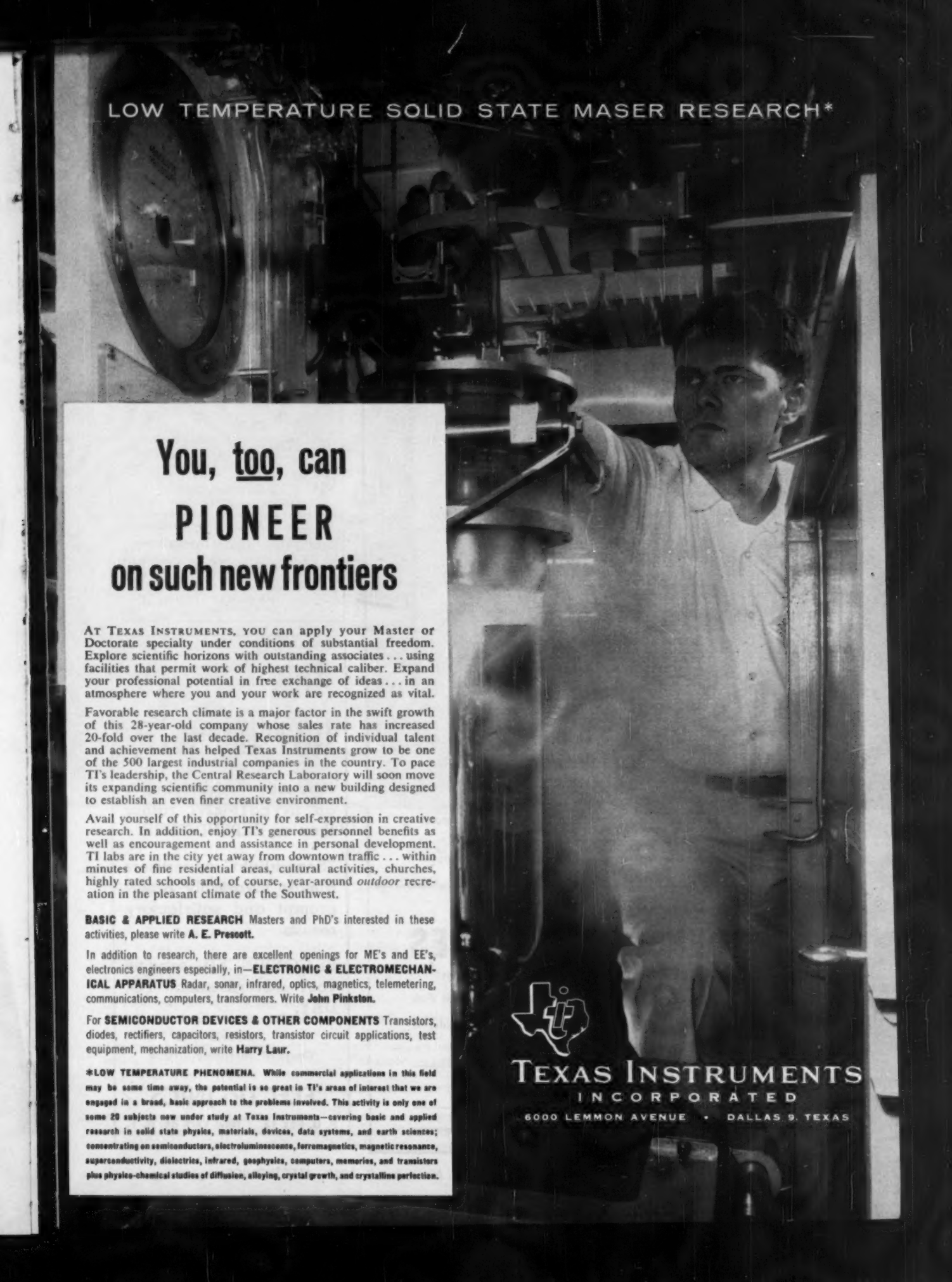

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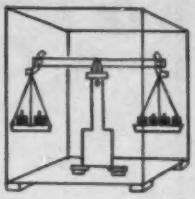

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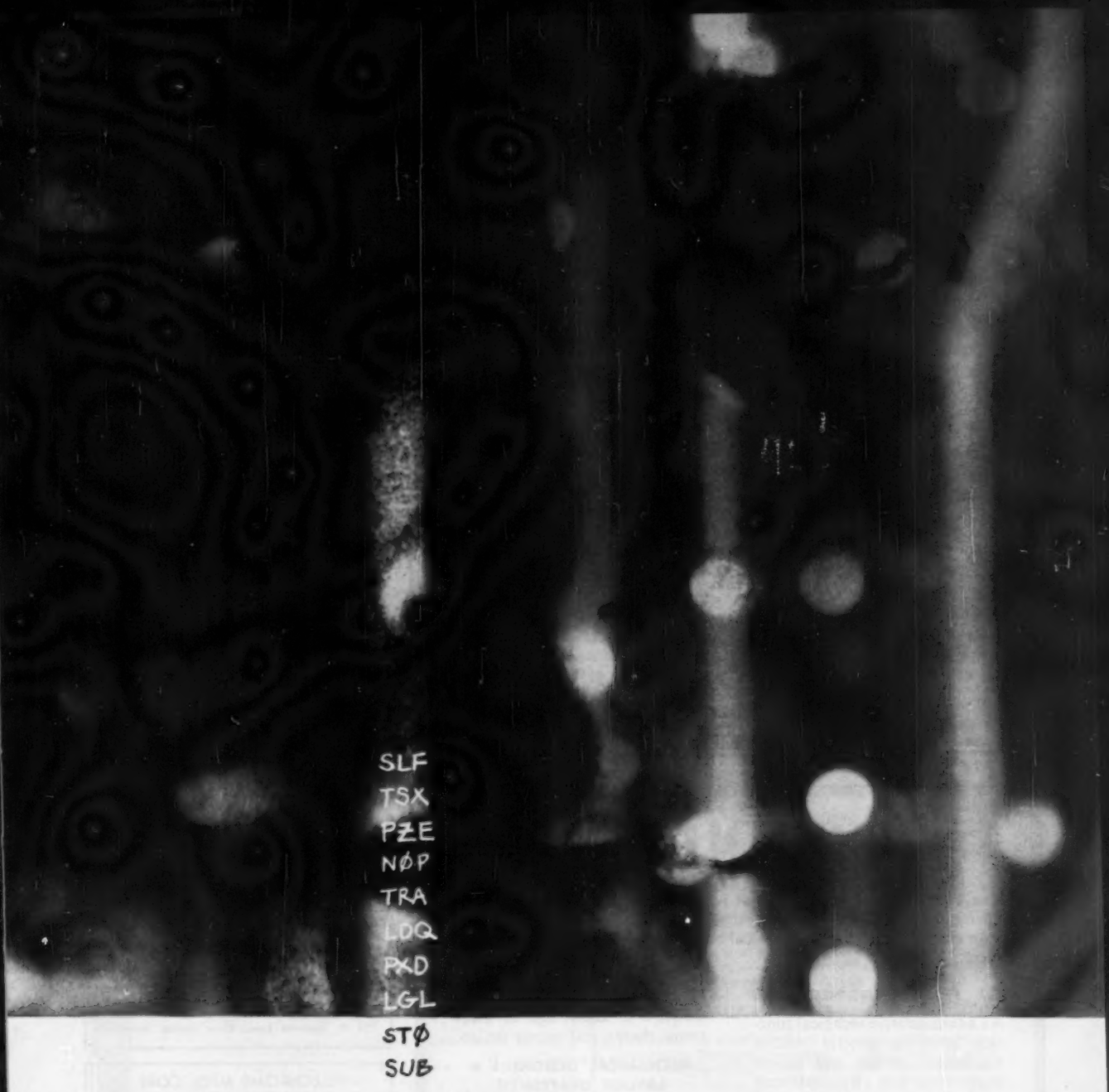

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A general knowledge of control type circuits and systems, analog and digital computers, audio systems, servo mechanisms.

JUNIOR ENGINEERS

Require a knowledge of electronic theory and circuit design.

MECHANICAL DESIGNERS & LAYOUT DRAFTSMEN

Experience on sheet metal fabrication, light structural units, gear trains and linkages.

ELECTRICAL DESIGNERS & LAYOUT DRAFTSMEN

Experience on chassis packaging, printed circuits, systems schematics and general wiring.

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2. transistorized industrial process control equipment.
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This is one of a series of professionally informative messages on RCA Moorestown and the Ballistic Missile Early Warning System.

RCA MOORESTOWN AND BMEWS

At its Moorestown Engineering Plant, RCA has centered the responsibility for direction of the BMEWS Project. As Weapon System Manager, RCA has the task of "turnkey" delivery of a fully integrated system for early detection of missile attack on this continent. BMEWS involves establishment of a discriminating and alert line for detection of aerial objects, coordinated with an intelligence center for interpretation and initiation of counter-weapon action.

There are unique technical problems in high radar power; long range; scanning and tracking techniques; interference from aurora and space objects and discrimination between such objects and missiles; advanced computer, multifunction data processing and display techniques. The BMEWS program also requires complicated coordinative assignments in supervising the large segment of the electronics industry cooperating in this effort. The complete scope and defense significance of BMEWS assignments are creating stimulating challenges in systems, projects, and development engineering.

Engineers and scientists interested in contributing to this program—and to other vital national defense projects—at the technical or management level are invited to address inquiries to Mr. W. J. Henry, Dept. V-10L.

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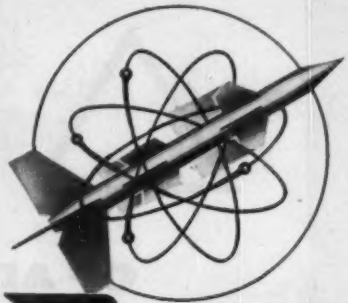

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12126-2-A Bendix Output: 26 volts; 3 phase; 400 cycle; 10 VA; 6 PF. Input: 27.5 volts DC; 1.25 amps. **$24.50**

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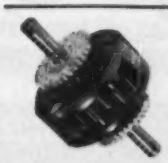

Size 2 11/16" long, 1 11/16" dia. 1-1 reverse ratio. ¼" shaft on each end; one shaft 25/32" long, one shaft 15/32" long. Input and output gear 1-23.32" dia. 53 teeth. Stock No. 150 **$3.50 ea.**

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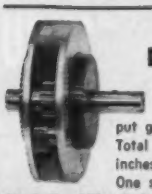
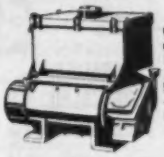


1 to 1 reverse ratio; 48 teeth on input and output gear, 1-1/32 inch diameter. Total outside diameter 1-25/32 inches. Shaft size is ¼ inch. One shaft is 9/16" long; other shaft is 3/16" long. **Stock No. 151 $5.00**

ONAN MOTOR GENERATOR SET

MG 075-G-1



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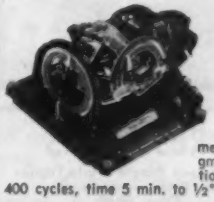

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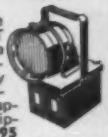

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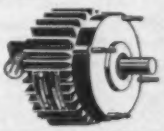

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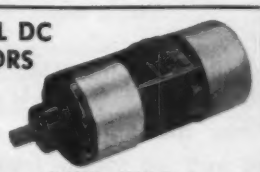

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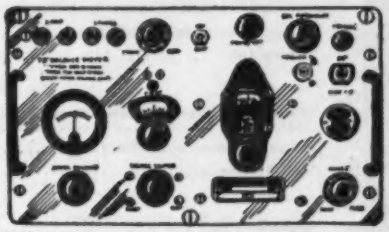

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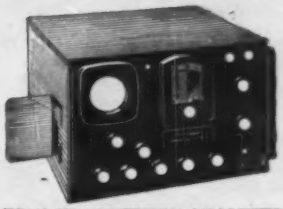

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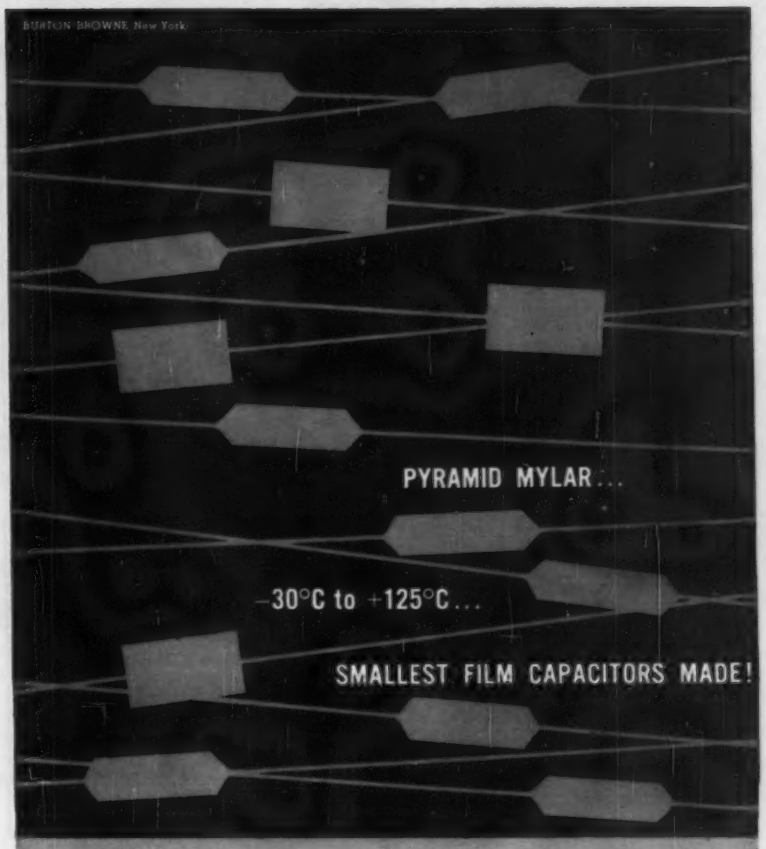

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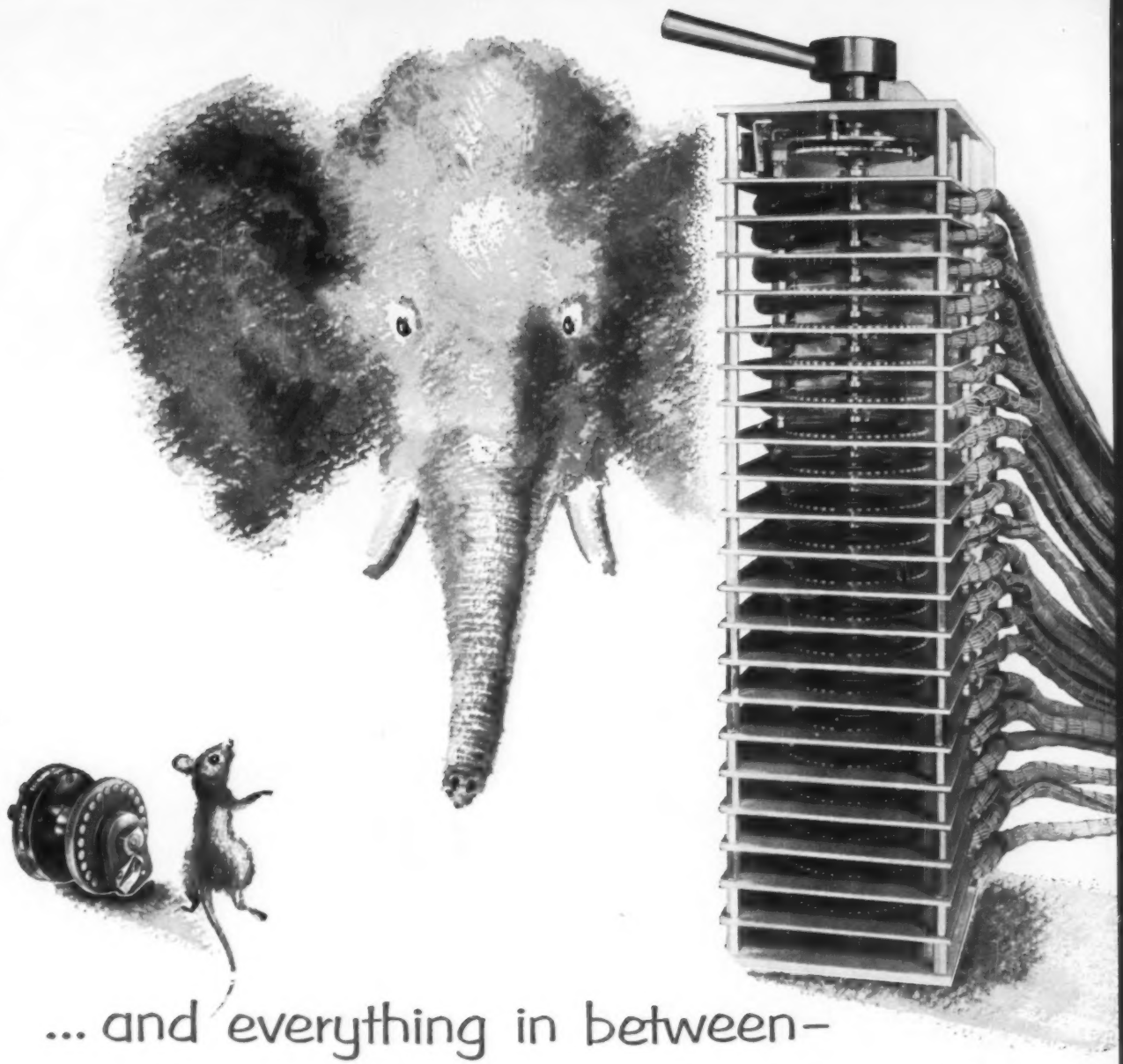

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